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AIR FORCE

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Air Base–Community Planning...

Randolph AFB Study Group Leads The Way

AFCE Leaders You Should Know

. . . Col James O. Putnam, PE

When Jim Putnam received his bachelor's degree in civil engineering from Michigan College of Mining and Technology in 1952, he also accepted his ROTC commission as a second lieutenant in the U.S. Air Force. Nothing is unusual in this sequence of events as it has come to be a commonplace occurrence for hundreds of young men at hundreds of colleges and universities across the nation.

Since the awarding of his first college degree and his entry into the military, that one aspect which lifts his career from the average to the distinguished is his unquestioned determination in attaining several goals which are sought by many yet achieved by few.

In a span of 20 years, he has earned two additional degrees; held down responsible positions in a variety of civil engineering research and development areas; progressed through the ranks to that of Colonel; and only recently nominated for the rank of Brigadier General. When he pins on his star, he will be one of two general officers within the civil engineering career field who possesses a doctorate degree, specifically a doctor of science in civil engineering.

Having achieved success in educational endeavors as well as military rank, the assumption could be that "it's all down hill from now on. He has reached the pinnacle." The absurdity of such an assumption is quickly dispelled after a discussion with him. Just as his unflinching determination resulted in his previously mentioned successes, that determination reveals itself in his attitude and zeal for success in his current position as Deputy Chief of Staff, Civil Engineering, Headquarters Military Airlift Command (MAC), Scott AFB, Illinois.

The mission of MAC is to deploy and support the Armed Forces of the United States wherever and whenever they are needed. The mission of MAC Civil Engineering is to maintain the facilities of the command whose responsibility and presence is felt worldwide. MAC has 10 bases, is located at 20 other principal installations around the globe and has a real property worth of almost $1 billion. Through the system, it moves approximately 225,000 passengers and approximately 40,000 tons of cargo a month. It is in these two areas that Colonel Putnam faces his biggest problems.

"We want to modernize our terminal facilities to reflect the best standard of maintenance in efficiency, cleanliness and ease of operation. In cargo handling, we want to capitalize on our strategic airlift capabilities as provided by the C-141 and C-5," he said.

Comparing his problems with those he believes are the most critical within Air Force Civil Engineering, he made these observations. "We must continue to upgrade the quality of our plant. We need good, fundamental design which incorporates facility maintainability. In other words, when we design new facilities, let's design them with the objective of eliminating as much future maintenance as possible." The impact of this type design, he predicted, will definitely improve the living and working conditions of all our personnel.

Prior to his current position, the native of North Carolina served as the Chief of the Hard Rock Silo Division, Minuteman Program Office, Space and Missile Systems Organization, Air Force Systems Command. This position is a reflection of his acknowledged expertise in civil engineering as he has worked extensively in the research and development field to develop new techniques for the design and construction of Air Force facilities. Other positions he has held include Project Scientist, Defense Atomic Support Agency, Washington, DC; Deputy Commander and then Commander of the 820th CES (RED HORSE), Tuy Hoa, Vietnam; Director of Engineering Management, DCS/Civil Engineering, Air Force Academy; and Chief of the Facility Technology Section, Air Force Weapons Laboratory, Kirtland AFB, New Mexico.

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In conclusion, he offered the following as his advice to the young man who is now entering the career field: "Capitalize on every opportunity that is presented to you. By the same token, don't expect to be on the receiving end of every good opportunity that becomes available. Look for work; become an authority on an aspect of engineering in your own way; and garner for yourself a piece of the action. It can be done."

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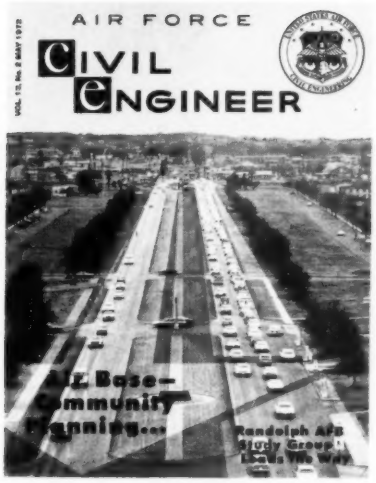

AIR BASE - COMMUNITY PLANNING. Randolph AFB is faced with the problems caused by surrounding urban growth. See Page 2 for the details on how the base and communities are working together in a cooperative effort to solve mutual problems.

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Randolph AFB Subregion Thoroughfare Study Group Leads the Way

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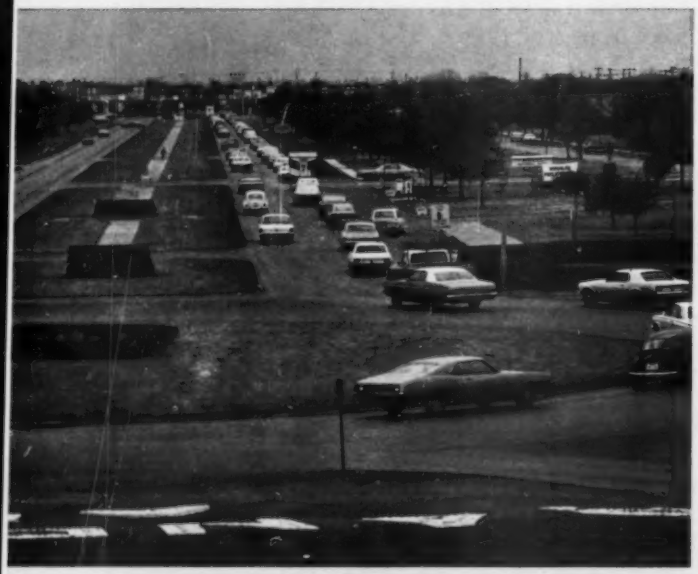

Peak hour traffic at Randolph's main gate is complicated by the train crossing in front of the gate.

MICHAEL DONOVAN *had served as Assistant Branch Chief, Master Planning Branch, Headquarters Air Training Command, Randolph AFB, Texas, until his recent retirement from the Air Force. He received his bachelor's degree in civil engineering from the University of New Hampshire, and his master's degree in civil engineering and master of city planning degree from Georgia Institute of Technology.*

The Randolph Subregion Thoroughfare Study Group is a unique example of joint air base-community planning in which Randolph AFB, Texas, and its surrounding communities are cooperating in a study aimed at solving mutual traffic problems. In an era when many Air Force bases are increasingly threatened by urban encroachments on operational capabilities, the Randolph Subregion Thoroughfare Study may well become a model for inter-governmental cooperation.

To fully appreciate the efforts of the Study Group, one must first understand the nature of the urban encroachment problem. Urban encroachment is a major problem for the Air Force. Many bases constructed in sparsely populated areas during World War II became encompassed by urban and suburban growth during the 1960s. Problems related to urban encroachments on mission capabilities curtailed flying operations at some air bases. During 1971, Air Training Command (ATC) alone had three major encroachment incidents dealing with such diverse problems as noise protests from a school; security problems related to increasing vehicular traffic around a base; and, subdivision plattings within an intense noise zone.

Randolph AFB is a typical example of an air base faced with meeting the problems caused by surrounding urban growth. Randolph AFB was built in 1930-31 "in the middle of nowhere." It was known as the Air Corps Primary Flying School in the years prior to World War II. Its flying mission has always centered around some type of flying training, and currently, Randolph AFB houses the Instrument Pilot Instructor School and all Pilot Instructor Training. Two important non-flying missions greatly influenced the growth of both the base and its surrounding area. In 1957 Headquarters ATC was consolidated and relocated to Randolph AFB and in 1964, the U.S. Air Force Military Personnel Center was located there. These mission changes added over 3,500 employees (military and civilian) to the base's strength.

Randolph AFB is surrounded by five rapidly growing communities which, together with the base, form the area called the Randolph Subregion. Universal City, the largest of the five communities, has sprung up, literally, right outside the front gate of the base. It has grown outward from the base along both sides of Pat Booker Road, which is the main route from Randolph AFB to San Antonio via Interstate Highway (IH) 35. Universal City's population has grown from 1,800 in 1960 to over 8,000 in 1972. Further out Pat Booker Road, at its intersection with IH 35, is the community of Live Oak. Live Oak was non-existent in 1967. Its present population is about 4,300. The city of Schertz borders Randolph AFB on the northeast. Schertz's population has grown from 2,300 in 1960 to over 5,000 in 1972. Additionally, Converse with a population of 1,500 and Cibolo with a population of 480 lie, respectively, three miles west

and three miles east of the base. The present population of the entire subregion is 21,000. Schertz and Cibolo are in Guadalupe County while the remaining communities are in Bexar County.

The Randolph Subregion Thoroughfare Study Group owes its existence to the Randolph Community Council, which was formed in 1970. Randolph AFB's Commander realized that problems affecting the communities were indirectly its problems since much of the communities' population consists of Randolph's civilian and military personnel and retired Air Force personnel; thus, the Community Council was formed to jointly attack mutual problems.

The Randolph Community Council is composed of the Randolph AFB Commander, the mayors of each of the five surrounding communities, and commissioners from both Bexar and Guadalupe counties. The Council meets monthly at Randolph AFB. The chairmanship of the meeting rotates among Council members, and the agenda for meetings cover a wide range of topics. Everything from drug problems to dog catchers is discussed by the Randolph Community Council. The Council is not merely a forum; it has appointed subcommittees to develop action programs aimed at solving mutual problems.

In early 1971, the Community Council identified traffic safety as being one area in which the communities could immediately begin to work together effectively. A subcommittee, the Randolph Traffic Safety Council, was formed. The Traffic Safety Council was composed of the police chiefs from each community and was chaired by the Randolph Chief of Safety.

The Traffic Safety Council immediately realized that thoroughfare planning was one common problem affecting traffic safety in the Subregion. In recent years, Universal City, Schertz and Converse had all completed comprehensive plans under the HUD '701 Local Planning Assistance Program. These '701 Plans contained thoroughfare plans; yet, in most instances, the thoroughfare plans had not been coordinated among contiguous communities. Additionally, regional planning organizations such as the Alamo Area Coun-

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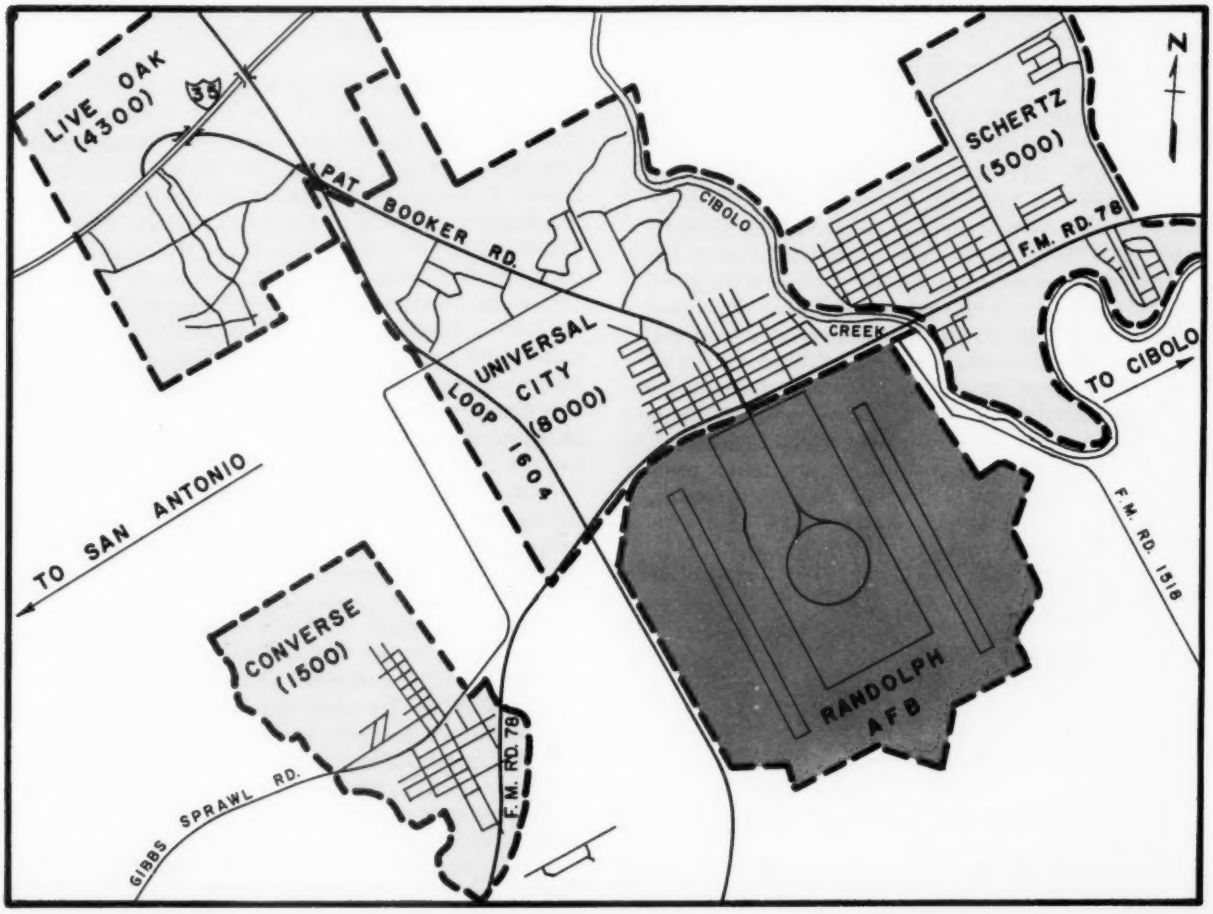
Randolph AFB and its surrounding communities of Universal City, Schertz and Live Oak are shown. The communities have grown from a combined population of 4,000 in 1960 to 17,000 in 1972.



Air Base—Community Planning *cont'd*

cil of Governments (AACOG) and the San Antonio-Bexar County Urban Transportation Study (SABCUTS) were conducting regional transportation planning and were asking for local input from communities in the San Antonio metropolitan region.

Traffic problems were growing around Randolph AFB. A 1969 SABCUTS origin-destination survey showed that Randolph AFB generated 35,875 vehicle trips per day, which was the seventh highest vehicle trip generation total among the 425 survey districts in metropolitan San Antonio. These trips passed through one or more of the five communities surrounding the base, and the heavy volumes created, often overtaxed the major elements of the communities' street networks, which had been built many years ago to handle rural traffic volumes. Thus, traffic congestion and increased traffic safety hazards were becoming daily problems in each community.

Randolph AFB was experiencng its own unique traffic problems. The duty hours of the three major work forces were staggered as efficiently as possible, yet vehicle delays of 15 minutes or longer were becoming frequent at each of the base's three main gates. Base officials feared the consequences of any event which might require a mass, unstaggered evacuation. Additionally, the Randolph Base Civil Engineer (BCE) was studying several major proposals to improve access to Randolph AFB, and each method being studied had an impact on the off-base street network.

In response to the growing transportation problems in the Randolph Subregion, the Traffic Safety Council appointed the Randolph Subregion Thoroughfare Study Group to study thoroughfare planning in the Randolph Subregion. In March 1971, the Study Group was charged with the following four preliminary responsibilities:

- Recommend a specific study area.
- Determine what elements are required in a thoroughfare planning study of the Randolph Subregion.
- Determine what resources are required to accomplish such a study.
- Report back to the Traffic Safety Council with a plan for accomplishing the study.

The Study Group is truly intergovernmental. It is composed of voting members from each of the five communities and Randolph AFB, plus non-voting liaison members representing AACOG, SABCUTS, the Traffc and Transportation Department of the city of San Antonio, the Bexar County Road Administrator, Guadalupe County, and Headquarters ATC. The BCE represents Randolph AFB on the Study Group and serves as vice-chairman.

When the Study Group was formed, it was realized that technical expertise in the field of transportation planning would be essential to the success of the Study Group's efforts. Headquarters ATC Civil Engineering agreed to provide an officer who possessed a background in urban planning and transportation planning to the Study Group, on a full-time basis, for a temporary, two-month period. This officer chaired the Study Group for the first month of its existence.

One of the Study Group's initial accomplishments was an origin-destination survey of Randolph AFB which was conducted with technical assistance from the U.S. Army Transportation Engineering Agency. The survey collected data about the living zones, work zones, approach roads, entrance gates, and exit gates for work trips made by the base's 9,000 employees. The data were summarized in a survey report which presented a complete picture of peak hour travel patterns to and from Randolph AFB.

Report Outlines Objectives

The Study Group accomplished its preliminary responsibilities and presented a report entitled, **A Report Concerning Transportation Planning in the Randolph Subregion,** to the Traffic Safety Council. The Report outlined the objectives for a subregional transportation planning effort, the work elements needed, and methods for accomplishing such a study. It recommended that the five communities and Randolph AFB, acting jointly, hire a transportation planning consultant to accomplish a subregional thoroughfare planning study. The recommendation was passed along to the Community Council which approved it in June 1971.

Lacking expertise amongst its members, the Study Group again called on Headquarters ATC Civil Engineering for technical assistance in developing the study design. Headquarters ATC responded immediately and designed a two-phase subregional thoroughfare planning study to be completed within nine months based on the work elements described in the initial Study Group report.

Phase I of the study consists of the gathering and analysis of pertinent background data. The study design stipulates that the consultant shall investigate the economy and population of the subregion in order to provide an insight into the forces which will generate growth and the resulting demand for transportation facilities and services in the subregion. Land use data are to be studied to establish a relationship

between land use and trip generation for the subregion. Additonally, the consultant must collect and study data about the physical adequacy of transportation facilities, traffic volumes, travel times, mass transportation services and travel patterns.

Phase II stipulates that the consultant shall prepare a thoroughfare plan for the Randolph Subregion, based on the data collected and studied during Phase I. The study design lists specific traffic problems for which the thoroughfare plan must propose solutions, and stipulates that the consultant shall recommend standards for street construction and construction priorities based on accurate cost estimates.

The most complex problem encountered by the Study Group involved negotiating and contracting the study. A number of factors complicated negotiating and contracting procedures. For instance, Air Force procurement regulations did not include procedures for Air Force-community joint financial participation in planning endeavors. Additonally the Air Force funds available for the study were EE 532 Architect-Engineer funds, which could only be disbursed by an Air Force contract. Thus, there was no way for Randolph AFB and the five communities to participate together in a single contract for the study.

Therefore, the following contracting procedures were developed:

- The study would be accomplished by two contracts. An A-E contract would be executed between the consultant and the Randolph Procurement Officer. A second contract would be executed between the consultant and the five communities.
- The total study cost would be negotiated jointly among the first choice consultant, the Randolph Procurement Officer and the Study Group.
- The negotiated total study cost would then be prorated between Randolph and the Study Group.
- The study design, in the form of a prospectus, was sent to a number of transportation planning consultants in Texas. Eventually a contract was negotiated with Clifford Cason and Associates, Inc., consulting engineers with offices in San Antonio. On 1 February 1972, the Randolph Subregion Thoroughfare Study was under way.

In analyzing the events leading to the signing of the contract, certain keys to the success of the Study Group's efforts are evident:

1. **Commander Involvement:** There is no substitute for the active involvement of a Wing/Center Commander in community relations. The Commander is the only one who can authoritatively commit a base to an active program of community involvement. Historically, Randolph's commanders have always been deeply involved in community affairs, and the Randolph Community Council was the starting point for thoroughfare planning in the Randolph Subregion.

2. **Active Communities.** Air base-community planning is a two-way street. Communities must be active participants. Randolph AFB is fortunate in being surrounded by five communities which realize the importance of planning with the base.

3. **Technical Expertise.** The availability of technical expertise in transportation planning was essential to the Study Group's efforts. The Randolph Origin-Destination Survey, the initial Study Group report, and the study design could not have been accomplished without the technical assistance that was provided by Headquarters ATC Civil Engineering.

4. **Active Regional Planning.** Coordination with regional planning bodies must be part of any area-wide planning effort. The staffs of the Alamo Area Council of Governments and the San Antonio-Bexar County Urban Transportation Study provided extensive assistance to the Study Group.

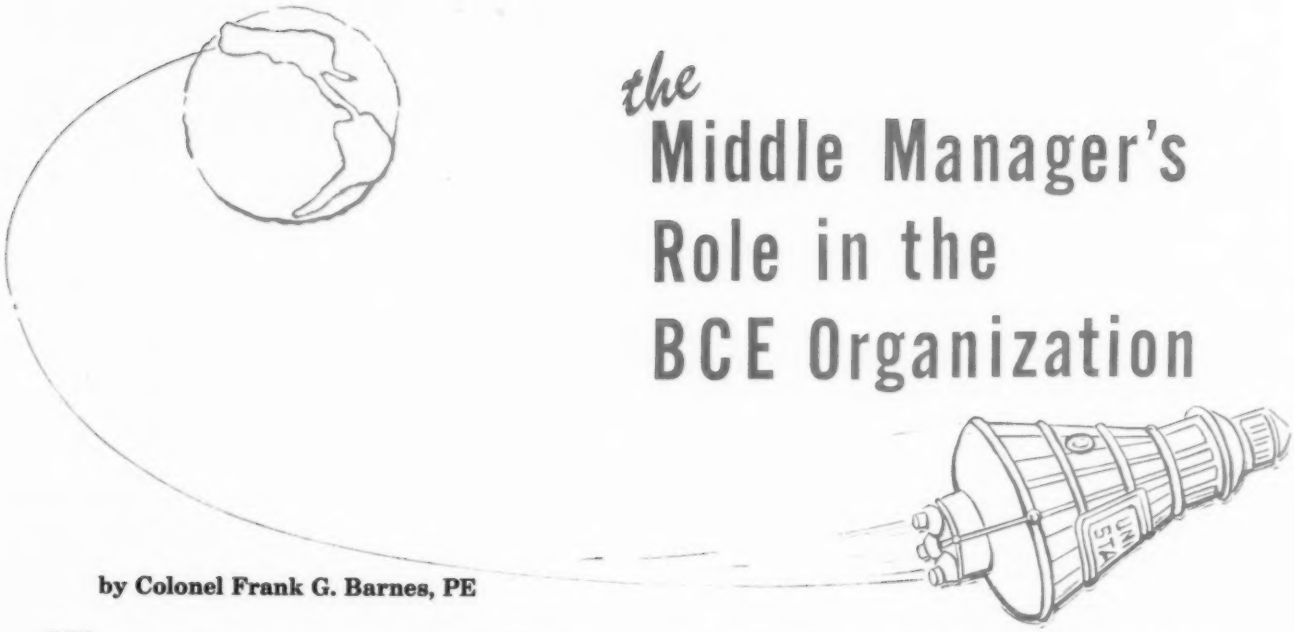
5. **MAJCOM Support.** Support from headquarters ATC Civil Engineering played a major role in the Study Group's success. In addition to providing technical assistance, Headquarters ATC Civil Engineering made funds available to Randolph AFB for the thoroughfare planning study.

6. **Availability of Consultants.** The Study Group was fortunate in that a number of engineering/planning firms are based in San Antonio. Contracting with an out-of-town consulting firm might have proved to be too expensive for the Study Group.

The Randolph Subregion Thoroughfare Study Group is an excellent example of local governments and public agencies working together to solve mutual problems. Much thoroughfare planning work remains to be done, but the fact that the various governments have put money on the line to back the Study Group's efforts speaks for itself. Additionally, based on the thoroughfare Study Group's success, the Randolph Community Council has appointed the Randolph Airport Environ Study Group to investigate the entire problem of planning around Randolph AFB. The Randolph Subregion Thoroughfare Study Group is an important step in maintaining the operational capability of Randolph AFB.

Bumper to bumper traffic logjams like this led to participation in the subregion thoroughfare planning study.

"It's time that AFCEs . . . get with the jet and space age . . ."



the Middle Manager's Role in the BCE Organization

by Colonel Frank G. Barnes, PE

Within Tactical Air Command (TAC) major inroads are being made into the cleanup of Inspector General discrepancies. Needless to say, this is a major undertaking and it requires management support and action at all levels, and particularly at the middle manager level. What is the biggest lesson that has been learned? It is the dire need for education and communication throughout Air Force Civil Engineering. All the management systems in the world are meaningless and wasted if the people who must interpret and implement them do not understand the reasons for and the advantages to be gained from such tools. One prime example in this lack of education and communications has been the past failure to implement the management system of Total Programming, a concept which is now about four years old.

Despite the efforts, guidance and direction from higher headquarters, Total Programming and its inherent management benefits had taken a back seat, not only at TAC, but throughout the Air Force. The Engineer-Manager part of Total Programming had also been deferred or delayed or, in some cases, was almost nonexistent. Two major reasons for this reluctance of implementation were discovered. One was the lack of command emphasis and the other was an inaccurate evaluation of the total workload associated with the initial implementation, especially in consideration of the potential benefits. In most cases, the people directly involved with the implementation of Total Programming had never fully evaluated the reason for Total Programming and why it was being stressed with so much emphasis by higher headquarters. In essence, there had been a serious breakdown in communications at all levels, and higher echelons had failed to provide the educational vehicle to sell the program. No one had explained all of the benefits to be gained. And, that brings to mind a story.

This involved a large company that was in the process of developing a major retirement plan. The companies to be affiliated with this plan required total involvement of all personnel. There seemed to be no problem except for the one dissenter, old Joe. Despite interviews, consultations and you name it – old Joe refused to participate. Finally, the president of the company who was a life-long friend of Joe's called him in, and after getting nowhere, looked Joe straight in the eye and said, "Sign up or you're fired!" Joe smiled, started to walk out of the office, but said, "Fine, where do I sign up?" Then the boss was interested in knowing what changed Joe's mind. Joe's reply was, "This is the first time that anyone has told me all the benefits of this program."

This is my purpose in discussing Total Programming. Sometimes we have to understand the inherent benefits of any management tool in order to sell the implementation. Total Programming, basically, is identification, validation and proper programming of total requirements, regardless of fund source into a five-year plan. The question arises, Why a five-year

plan? Basically, all DoD programs are based on the FYDP, the Five-Year Defense Plan. Civil engineer requirements should use the same base line. This is not to say that the five year program developed this year will cast you in concrete—it will not. As with all plans associated with the FYDP, there is continual revising and updating.

The total DoD budget is based on FYDP and each year dollars are earmarked for O&M and MCP requirements. The funding level is based on the submissions by the component services. In the past, the Air Force submissions to support our O&M and MCP requirements have been something less than acceptable. This is evidenced by the fact that of the total FY71 DoD deficiency of the $19 plus billion in the MCP area, the Air Force portion was only recognized as $4.6 billion, yet the Air Force owns 43 percent of the DoD real property inventory. Both the Army and Navy had about $7.5 billion as their recognized deficit. As a result, when OSD divides up the MCP dollars in the FYDR, the Air Force gets less than the other services. The same type of situation prevails in the O&M area. The O&M dollar requirements for payrolls, utilities, supplies, etc., are relatively easy to calculate based upon program documents in support of the FYDP. However, when we come to the O&M projects by contract area where Total Programming plays such an important role, we are in trouble again with OSD. This past fall, we had to furnish the OSD Comptroller and the Bureau of the Budget a 1391 for all projects estimated to cost over $200,000 which we propose to do by contract in FY-73. These were used in preparation of the President's budget request to Congress in January. This June when we seek apportionment of the funds in the President's budget, we will again have to list this category of projects by contract. The DoD and BoB guys are tricky—they will compare the two lists and all too frequently they will find little if any similarity. Within about seven months, we change so much that we lose credibility and this results in funds being withheld. Total Programming with development of sound five-year O&M, MCP, and NAF programs can alleviate these problems.

The same degree of importance can be attached to work force productivity, supply discipline, industrial engineering, and so on. The Chief of Staff has continually emphasized that we have to do more with less. Manpower strengths are going down so the remaining work force must pick up the full load and be more productive. Budgets are being reduced and the end to inflation is not in sight, so we cannot afford to have any supply dollars tied up in materials that cannot or will not be used to support the mission. Industrial engineering is relatively new to civil engineering and, unfortunately, a lot of the "old Joes" in our business have refused to recognize its importance and utilize its benefits. New ways of doing an old job better is a way of life throughout industry and it is time for Air Force Civil Engineers to remove themselves from the horse and buggy days and get with the jet and space age.

You may ask, how are engineer-managers involved in the scheme of things? Engineer-managers are where the action really is. Just about everything starts with the middle manager. No, the engineer-manager does not directly make all the big policies and top decisions, but in the same sense that a large brick building is made of many bricks supported on a foundation, the middle manager is the foundation who supports the bricks, the basic policy and management concepts which keep the work force gainfully employed.

The middle manager, in turn, is the responsible individual who implements these policies, concepts and decisions, and works the bugs out of them. He is the individual who is relied upon to make the best of every situation and insure that the operation moves forward to accomplish the mission, and, of course, come up with some practical and necessary changes to improve the operation.

Make no mistake, we in the headquarters clearly realize that the middle manager plays a most important role in the management process. This is one side of the middle manager as seen by higher headquarters. But what do we see on the performance side of the picture? As in all work areas, performance ranges from excellent to poor. Almost always we see hard workers. We see people striving to get the job done, but, working and striving to get the job done isn't always the whole story. Proper performance must include proper management. We see in many managers, and this applies from the very top all the way down, complete failure to take on the responsibility as managers. You are a manager. You are a part of management. This is not to say you don't do work. A manager works a little harder than one who is not a manager. A manager should support his people, but must remain identified with management. A manager must utilize resources to the best of his ability, yet we see middle managers putting off or refusing to make decisions that are rightly theirs. We see others that want the grade, but feel it's not their responsibility to make decisions. Still others feel or act as if they feel that their part of the management process is so unimportant that no one cares anyway. But, we see the majority shouldering a full load, carrying on in the face of many problems.

From time to time, some managers may wonder just what their role really is in the management process. Their part in policy making and decision making is a direct relationship to what they put into the management effort. In other words, pick up your total area of responsibility and run with it. Don't wait around for someone to tell you. Carry the ball when

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Manager's Role
cont'd

it is thrown to you. No supervisor can pass on decision making responsibility until we have proven we are up to the task.

In TAC we are pushing improved use of management procedures and systems at each base with an overall goal of increased productivity. We are also placing special emphasis on Total Programming, industrial engineering, quality control, and material control. We fully realize that **not** one of these programs will get to first base without the cooperation and help from middle level management. Improvement in any of these areas is dependent on management. The heart of Total Programming is the middle manager. We feel we have made great strides toward implementation of Total Programming in recent months. There is still much more room for improvement. We know full well that the performance of managers is largely responsible for any progress made toward implementation of Total Programming, or other special programs, and will be responsible for progress or lack of progress in the future.

A most important role of the middle managers as viewed by higher headquarters is their use of available resources. We talk a lot about how we can't do the job unless we get more money and more people. Yes, we agree there is a universal shortage in money and people, but once we have done everything possible to correct this condition, the one remaining action is getting on with the program. We see the middle manager as one who manages available resources as necessary to accomplish maximum productivity. Too often we see managers gripping about what they don't have and telling how they can't do this or that job. At headquarters, we look to you to exert your effort toward getting the best job possible with what you have to work with. Your most important decisions lie in placing work items in proper priority so as to best support the mission of real property maintenance and operation within available resources.

Now, what is the higher headquarters doing for the middle manager? Do the following sound familiar? Issuing policy letters, supplements, regulations, and manuals; cancelling projects; changing priorities; establishing unrealistic suspenses; sending out search and destroy teams; and generally laying on impossible work loads in every possible manner.

We each have a mission to carry out and must establish policies and procedures to insure that this mission is completed within an established time frame. Two major items control the need for all this policy and procedure. First, the need for some measure of standardization. As we go from base to base we find as many ways to accomplish a job as there are bases visited. Each base feels of course that their method is best; however, one base is using three people to do a job where another base uses five for the same job. Seldom is the completed product comparable. Training of the military that move from base to base under these conditions is impossible. Manning, funding and equipping is also next to impossible without standardization. Consequently, from the practical viewpoint, standard policies and procedures from the higher headquarters is most essential.

The second item of control is that each higher headquarters also has a higher headquarters which originates at the President and flows down through DoD, Air Force, etc. As much as all of us would like to get away from restraints, these controls or constraints will always be with us to varying degrees as long as we continue to live in a democratc society.

Our only solution is application and implementation to the best of our ability with the resources available. However, we should never stop our effort to improve ourselves through evaluation and request for changes to the directives. We in the headquarters welcome practical, well thought out change requests. In making this statement, always evaluate any request for change as to how it will effect other bases. What law or directive would prevent this change? Where did the directive originate in the first place? What do other base people think of your idea, etc? We feel that each manager, regardless of what level, should know his counterpart at the higher headquarters and at a number of other bases, and should discuss common problems regularly.

In closing, the mission of the Air Force, particularly the civil engineer, is being supported. Also, Air Force base appearance is outstanding, compared to other services and comparable industrial complexes. This is a tribute to middle management, since controlling the work force and directing the utilization of resources is the middle management basic responsibility.

In summary, three basic points should be remembered:

1. Be a real manager, effectively utilize the resources entrusted to your stewardship.

2. In your area of responsibility, pick up the ball and run with it. Remember, the man who has never made a bad decision has never made any decisions.

3. Give your full support to the management team. That is what you were hired and are paid to do.

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paths to progress

By Lt Col Sheldon J. Lustig and A. M. Crawford, PE

"The main point: To get you and the people you work with fired up to achieve whatever goals you select. And always remember: Getting there isn't half the fun — it's all the fun."

Robert Townsend, former President of AVIS Rent-a-Car Company, used the above advice to introduce his recent best seller, **Up The Organization.** When his book was published in the summer of 1970, AVIS was advertised as "Number 2."

At the same time, feedback from staff visits, Quality Control and Evaluation reports, Inspector General inspections, and our Westover AFB, Massachusetts customers indicated that the 99th Civil Engineering Squadron (CES) stood somewhat lower in the pecking order. The main difference between our organization and AVIS was the fact that they knew where they were going and had a plan for getting there. On the other hand, although our problems had been identified, no organized improvement program had been developed to "up the organization."

Program development became a first order of business. Criteria produced by early brainstorm sessions indicated a need for a flexible program which would provide a focus on subjects of prime importance; clearly defined goals; a framework for channeling future management action; and a systematic format for measuring progress.

Problems Identified

As noted previously, most major problems compromising the effectiveness of our organization had been identified prior to inception of "Paths to Progress." These problems were translated into the building blocks or "Paths" comprising the initial program. While defining the structure and philosophy of the program, we borrowed liberally from the ideas of Peter Drucker and Douglas McGregor in the book **The Human Side of Enterprise** regarding "management by objectives" and "target setting." In addition to satisfying criteria discussed earlier, we sought to decentralize planning, organizing and direction of individual Paths to a large degree. The increased decentralization of authority proposed also necessitated a shift from strong centralized control to application of the "exception principle" to the control function, (Newman and Summer: **The Process of Management.**).

Our initial 17 Paths were dictated by existing conditions and a need to get started. Subjects of the original program are listed in **Figure 1.** Other significant problems and meaningful objectives which should have special interest focused on them, may be identified by any member of the organization as potential Paths to Progress or additional milestones within a Path already being followed. After ap-

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SKIP CRAWFORD *is an Industrial Engineer in the Management Division, Directorate of Civil Engineering, Headquarters U.S. Air Force. He holds a bachelor's degree from Virginia Military Institute and a master's degree from George Washington University. A graduate of the Air Command and Staff College, he is a registered Professional Engineer in Massachusetts.*

paths to progress

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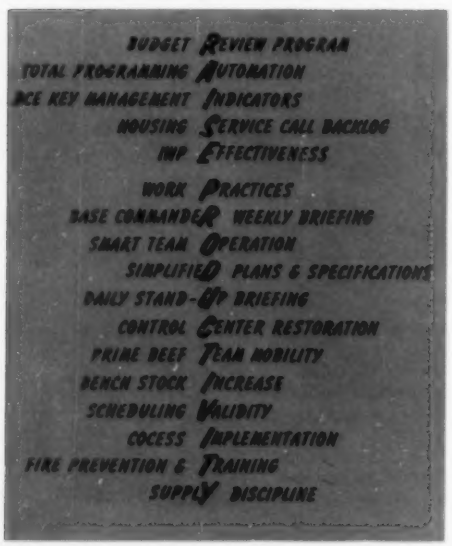
proval is obtained from the Base Civil Engineer (BCE), a Path monitor (OPR) is selected to organize and manage accomplishment of path objectives. Next, definitive tasks or milestones required to traverse the path are identified by the OPR. At the same time he sets target dates for reaching each milestone and ultimately the final objective. Proposed milestones and target dates are discussed by the OPR with the BCE to establish mutual understanding and agreement regarding major elements of his Path. When agreement is reached, a "Path Guide" is developed by the monitor and added to "Paths to Progress" handbooks which are maintained by each branch chief and individual OPR. These handbooks also contain program guidance, operational instructions, copies of active path guides and progress measurement records for individual paths applicable to the respective managers. As shown in **Figure 2,** each Path Guide explains the specific objective of the path and includes a brief summary of our present status in regard to the subject covered. Data regarding the OPR start date, individual milestones and target dates make up the remainder of the guide.

Figure 1: Subject of Original Program



Measurement Charts Used

After a plan has been developed for solving a particular problem or reaching new objectives, positive action must be initiated and sustained. A method of control to monitor progress and remove obstacles also becomes essential. Control of "Paths to Progress" is exercised by use of measurement charts plus periodic progress appraisal conferences between the BCE and individual Path members.

Progress measurement charts similar to the one shown in **Figure 3** are maintained in the Production Control Center for each active path. These provide a capability for surveillance over the rate of progress and detection of deviations from milestone time tables. The transparencies from which progress charts are made are also useful for overhead projection whenever briefings are called for. Because the challenges which face us are not static, objectives, milestones and target dates sometimes require modification. Requirements for flexibility as well as feedback to management can usually be solved by periodic self appraisal conferences during which Path monitors have an opportunity to present an evaluation of progress to the BCE. When necessary, appropriate adjustments in milestones or target dates may also be agreed upon. During this phase, the BCE serves as a sounding board and consultant as well as evaluator of the rate and direction of progress toward the objective.

Progress Can Be Cited

Since the inception of Paths to Progress, we have been aware that the program could be stifled by waning interest, deviation from primary objectives or failure to amortize effort expended on the program by increased productivity or effectiveness of the organization. Although it is difficult to quantify increased productivity of any civil engineering work force, typical indications of progress can be cited. The number of routine jobs of the "nickle and dime" were significantly reduced from a two year to a more manageable 30-day backlog by employing more effective DIN, SMART and FAST systems.

Our production control center was re-established physically as a central organizational focus as well as substantively with a revamped weekly work scheduling process, the new positive personnel control system, the "visible" in-service work planning process, daily standups and weekly base commander update briefings. Our Fire Protection Branch was rated "excellent" by the 2nd Air Force Inspector General one year after receiving a "marginal" rating; all other branches showed marked improvement. An extremely successful COCESS was placed in operation; the payoff has been vastly improved supply support and customer response. Significant improvements were made in the squadron's Prime BEEF Program as staff visits and Inspector General reports will attest. An analysis of more than 2,000 quality control responses from our Westover AFB customers disclosed that a high

standard of performance was attained.

Finally, our first term airmen squadron retention rate of 53.8 percent for the first half of FY 1971 compared to four percent during the same period in FY 1970, the second highest rate of any CES in Stratetic Air Command and an incentive to "try harder." Foolhardy would be the claim that the 99th CES had achieved the pinnacle of organizational and efficiency success; after all, moving in the right direction down the path "isn't half the fun—it's all the fun."

At this time, it would be premature to make final judgments on the specific structure and management of this goal formulation and progress tracking process. However, in the short run, we can say that the 99th CES Paths to Progress program has provided a badly needed framework to meet its challenges. Experience tells us that some type of organized improvement program is a must for any organization, even for those at the top; for if No. 2 tries harder, No. 1's top rank is in jeopardy.

Emphasis Is on Control

A number of the original Paths have been completed and replaced by Path Guides oriented toward new problems. Other path guides have required modifications in subgoals, timetables and sometimes revision of the major objectives themselves. Instructions for management of the program have also been amended and we learned from experience that closer emphasis on control was necessary.

Ultimately, the success of our efforts will be judged by our Westover AFB customers, and professional peers at 2nd Air Force, SAC and Headquarters U.S. Air Force. Feedback from both indicates that we have made measurable progress in many areas vital to Civil Engineering Management and productivity. Meanwhile, Paths to Progress serves as a viable working tool to keep the 99th CES on the move!

(DEO-4) SCHEDULING VALIDITY

OBJECTIVE: To develop well planned effective work schedules which promote a high degree of compliance and credibility among our work force, commanders and customers. The desired outcome of this path is to upgrade productivity by limiting interruptions in planned work and improving coordination between our own forces as well as with other staff agencies and customers.

EXISTING STATUS: The current rate of deviation from weekly work schedules is unacceptable. This reflects numerous problems including inadequate planning, arbitrary deviation from schedules and unforeseen crash projects. Confidence in the credibility of existing schedules is presently low.

OPR: Captain Vance
DEO, Ext 3426

START DATE: 8 October 1970

COMPLETION DATE 15 December 1970

MILESTONES:

1. Develop test weekly work schedule format IAW guidance furnished by HQ 2AF and HQ SAC - 8 October 70 (Complete)

2. Publish schedule - distribute within Civil Engineering for test - 15-22 October 70 (Complete)

3. Publish first Weekly Schedule for approval by Base Commander. (No distribution beyond Civil Engineering) - 28 October 70 (Complete)

4. Test schedule effectiveness; analyze compliance; revise procedures as necessary - 4-11 November 70 (Complete)

5. Prepare first Weekly Schedule for Base Commander's approval and distribution to all major base organizations and tenants - 11 November 70 (Complete)

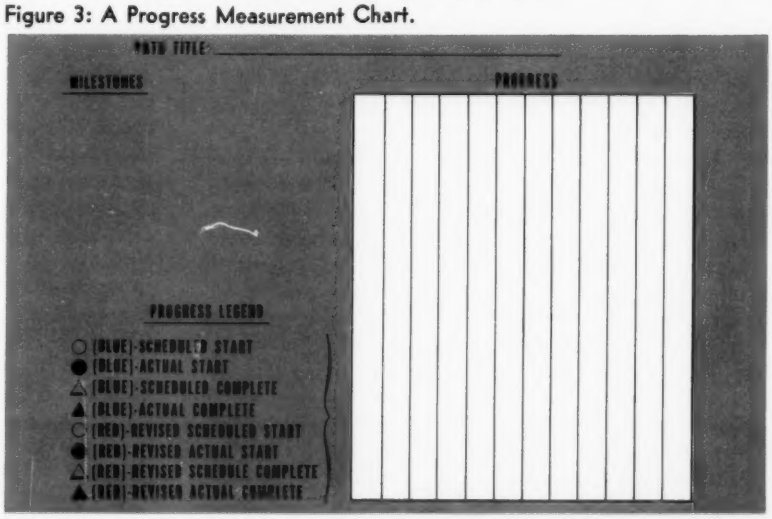
6. Analyze schedule deviations. (In-house distribution) 18 November 70 (Complete)

7. Brief schedule deviations. Initiate analysis and necessary corrective actions regarding significant deviations. 25 November 70 (Complete)

8. Develop procedure for distributing weekly work schedules to applicable family housing occupants - 15 December 70 (Complete)

Figure 2: Example of the Specific Objective of a Path.

Figure 3: A Progress Measurement Chart.



What About BEAMS?

by Col Clinton E. Pratt, PE

The Base Engineer Automated Management System (BEAMS) has been a favorite topic of authors and briefers in civil engineering since 1964. The virtues of the system and anticipated benefits have been extolled to the extent that most of us expected miracles to occur on the day that BEAMS went into operation. Today, we hear frequent expressions of disappointment concerning BEAMS. At conferences held by the major commands, Base Civil Engineers (BCEs) often remark, "BEAMS doesn't tell me what I want to know." The Inspector General says that during base visits many people are not familiar with and are not using BEAMS products. In our visits from Headquarters U.S. Air Force, we have also seen isolated instances where stacks of unused BEAMS products were collecting dust.

The time has come when we need to put BEAMS in the proper perspective. BEAMS is not a miracle system and was not expected to be. BEAMS will not solve all the problems of a BCE. It does, however, represent a substantial advance over our previous management information systems. It is years ahead of the systems presently used by the other Armed Services. It is being used at many bases; it is being improved; it will be better a year from today than it is now.

We need to stop talking about BEAMS as an entity. We have BEAMS for one purpose, that is, to provide management information. Part of this information is required to furnish reports to higher headquarters and, in some cases, all the way to Congress. The remainder of the information is useful to managers in base civil engineering and, selectively, the commands. In other words, BEAMS furnishes tools for management. It does not tell us **how** to manage. We need to focus our attention and efforts on doing the job using any management tool available. If a BEAMS product is or can be useful, we need to know about the product, understand how to use it and **use it.** Information is not useful unless it leads to action of some sort. BEAMS is not a useful tool until someone uses it. The fear is that much of the criticism comes from individuals who not only have not really tried to use BEAMS as one of their tools for management but probably could not read a BEAMS product if placed on their desks with the morning newspaper.

This all sounds pretty simple but just how do we go about convincing people to use management tools effectively? If we had an easy answer to this question it would simplify our job in the Management Division at Headquarters U.S. Air Force. About 2,000 people have been to the BEAMS school at Wright-Patterson AFB, Ohio, and additional training has been provided through the school at Sheppard AFB, Texas. Why then do we and others visit bases and find some people who not only do not use, but apparently are unable to use, the BEAMS products? Part of the answer is that our efforts to this point have been devoted to teaching people how to gather information for, and get the BEAMS system working, rather than how to use the information provided. A second problem is that we don't really know what information we need. Although some base engineers state that BEAMS does not give them the information they specifically need for the job, they are unsure of what BEAMS can tell them, and are unable to tell us what information they would really like to have. Opinions vary widely.

A work shop held at Vandenberg AFB, California, last March was attended by over 80 people from base, command and U.S. Air Force levels. The purpose was to examine the current BEAMS products, see what changes, additions or deletions should be made, and to evaluate the usefulness of the products in general to the BCE organizations. As a result of the work shop no products were deleted. Several changes and very few additions were made. The general consensus was that the products were pretty good. If the products are "pretty good" but are still

COLONEL PRATT *is Chief, Management Division, Directorate of Civil Engineering, Headquarters U.S. Air Force. He received his bachelor's degree in civil engineering from the University of Vermont and is a registered Professional Engineer in Vermont. He has served at base, command and Air Staff levels in civil engineering.*

not being used, then a lot of people working in a lot of base civil engineering organizations have some homework to do.

What can and is being done to make our use of BEAMS more effective? First, of course, are the system improvements being made by the Data Systems Design Center. The "bugs" are being taken out of the equipment maintenance program and the real property subsystem. Work is being done to adapt BLIS (Base Level Inquiry System) to provide ready inquiry capability, thereby eliminating the need for some of the present products. At the Air Staff, the current rewrite of AFM 85-1 has been modified to include useful information concerning employment of specific BEAMS products. We are taking a critical look at the essentiality of each product and will eliminate some. Some bases are beginning to make good use of BEAMS, generally those which have had the system in operation for a number of months. Classes have been successfully held at some bases to increase the knowledge and understanding of middle management. There are other signs of similar good progress.

The BEAMS data base contains a wealth of information. Collectively, we in Air Force Civil Engineering must find ways to make the system work for us.

VALUE ENGINEERING

by William A. Brown, Sr

One of the most effective techniques available to aid management in reducing costs is value engineering. It is applied by using a five phase job plan which incorporates technology and the principles of economics. Phase I, Information, is aimed at gathering all available information on a project and identifying essential functional requirements. Phase II, Speculation, consists of using brainstorming or other techniques to generate alternatives. These alternatives are Analyzed (Phase III) and final alternatives are Developed (Phase IV). Phase V, Presentation, consists of presenting and selling the most economical alternative. Throughout the application of the job plan, consideration is not only given to initial costs, but to maintenance and operating costs as well, Life Cycle Costs.

Over the past 18 months, the Civil Engineering Center's Value Engineering Team has conducted workshops at the major commands and Air Force Regional Civil Engineer offices. Two hundred forty-eight architects and engineers were exposed to intensive value engineering training. Part of these workshops was devoted to applying value engineering to projects selected by the hosts. These projects varied in size and type, and included dormitories, hospitals, freight terminals, sewage treatment facilities, commissaries, etc. Proposals amounting to more than 25 times the costs of the workshops were submitted. Because of the stages of design or construction, various mission requirements not previously identified, and lack of support by management, only **seven** times the cost of the workshops was implemented. Considering that the primary purpose of the workshops was training, a seven to one return for each dollar spent is respectable. However, we are striving for a minimum return of 10 to one for each dollar spent on value engineering studies. Since we now have a trained core of people throughout Air Force Civil Engineering, we urge management to fully use the training of these individuals by giving them the latitude and time required to conduct a value engineering study. Also, full support and consideration for all proposals and the selling of the proposals is needed.

When properly applied, value engineering can provide substantial savings. Examples of past proposals include:

On an Officers Quarters Project, prewaxed floor tile was used in lieu of unwaxed floor tile with subsequent in-place wax application, saving $1,600.

On a Commissary Project, PVC instead of copper was used for internal downspouts, saving $5,200.

On a Hospital Project, single caissons were proposed instead of double caissons since the allowable soil bearing pressure was sufficient. This saved $60,000.

Value Engineering is function oriented with the ultimate objective of satisfying essential functions at the lowest total cost. Therefore, management need not worry about its facilities being degraded or substandard; instead, when value engineering is applied properly, management will be assured of receiving a facility incorporating economical materials, systems, etc., that will result in lower total costs, as outlined in the examples above. By reducing facility costs, we can work within our budget to obtain and maintain more facilities. This will require concentrated effort by everyone.

WILLIAM BROWN *is an Architectural Engineer and Chief of the Value Engineering Team, Civil Engineering Center, Wright-Patterson AFB, Ohio. A graduate of Hampton Institute of Hampton, Virginia with a bachelor's degree in architectural engineering, he is an associate member of the American Institute of Architects and the Society of American Military Engineers.*

Send the people who can't

MANAGEMENT APPLICATIONS

Base Civil Engineer Course

Send the new officer and officer-grade civilian.

To familiarize him with Air Force Civil Engineering management systems, techniques and operations.

*** E&C Management Applications**

Send the Chief of the E&C Branch.

To help him better manage the E&C Branch.

BCE Staff Officer Course

Send the Base Civil Engineer or his Deputy.

To review management skills and their application to current CE management systems.

IE Techniques

Send the Civilian who works in the IE Branch who doesn't have an IE degree.

To develop some fundamental skills in Industrial Engineering.

*** IE Management Applications**

Send the Chief of the IE Branch

To help him better manage the IE Branch.

Executive Engineering

Send the top Base and MajCom managers (major or GS-12 Minimum)

To develop and broaden his management skills, attitudes, values and understanding of human motivation.

*** O&M Management Applications**

Send the Chief of the O&M Branch.

To help him better manage the O&M Branch.

*** Programs Management Applications**

Send the Chief of the Programs Branch.

To help him better manage the Programs Branch.

ENGINEERING TECHNOLOGY

Applied Engineering

Send your design engineer or architect "on the way up"

This rigorous course develops an understanding of electrical, mechanical and corrosion control theory and design process.

Air Conditioning Engineering

Send the mechanical engineering designer

To broaden his skills in applying current air conditioning design methods.

Building Systems Engineering

Send the design engineer or architect, or the construction management engineer concerned with buildings.

Theory and state of the art of Building Technology. Topics include roofing, protective coatings, fire protection and building economics.

CIVIL ENGINEE
FY-
COURSE O

t go!

Rules of the Game: "Send the people who can't go!", a quote from the current best seller "Up the Organization" by Peter Townsend, is the Civil Engineering School's theme for the year. Too often we find the chiefs too busy to attend courses. Or the chief feels his key people are too busy to attend so he sends a substitute. We should not send a man to school to "Boss the Boss."

The course offerings presented here are described in capsule. Please consult **AFM 50-5** for class schedules, complete prerequisites, letter of eligibility application procedures, enrollment information, fund citations and student reporting instructions.

Remember, per diem and travel funds for all USAF selectees are provided by AFIT. Travel outside the Continental United States is funded by the overseas commands. All personnel attending resident courses will be billeted at Wright-Patterson AFB unless they receive the personal waiver of their Command DCS/Civil Engineering. ANG, AFRES and MAP students will be considered for classes on a space-available basis.

Corrosion Control

Send the Corrosion Engineering-Manager or others responsible for corrosion control.

Broadens and increases skills in applying corrosion engineering principles.

Engineering Principles Refresher I

Send the engineer preparing for an Engineer - in - Training Examination (EIT portion).

To review fundamental engineering principles paralleling state examination subjects.

Engineering Principles Refresher II

Send the engineer preparing for a Professional Engineering Examination (PE portion).

Problem solving seminars divided into engineering disciplines of CE, ME, EE, IE.

Environmental Protection

Send the Environmental Engineer-Manager and Air Force Bioenvironmental Engineer (Bio-medical Sciences Corps).

To broaden skills in identifying and applying techniques for environmental protection and control.

*** Electrical Engineering**

Send the electrical engineering designer.

To increase his skills in designing electrical power systems.

Pavements Engineering

Send the Pavement Engineer-Manager or construction management engineer concerned with pavements

To update and increase his skills in soils and pavement technology (both flexible and rigid).

SPECIALIZED

Commanders' CE Orientation

Base and Wing Commander or his Deputy should attend.

To familiarize the Commander with Air Force Civil Engineering and how it interfaces with other Base organizations.

Fallout Shelter Analysis

Send the fallout shelter analyst or disaster control officer

A highly specialized course to broaden the architect or engineer's skill in fallout shelter design and analysis.

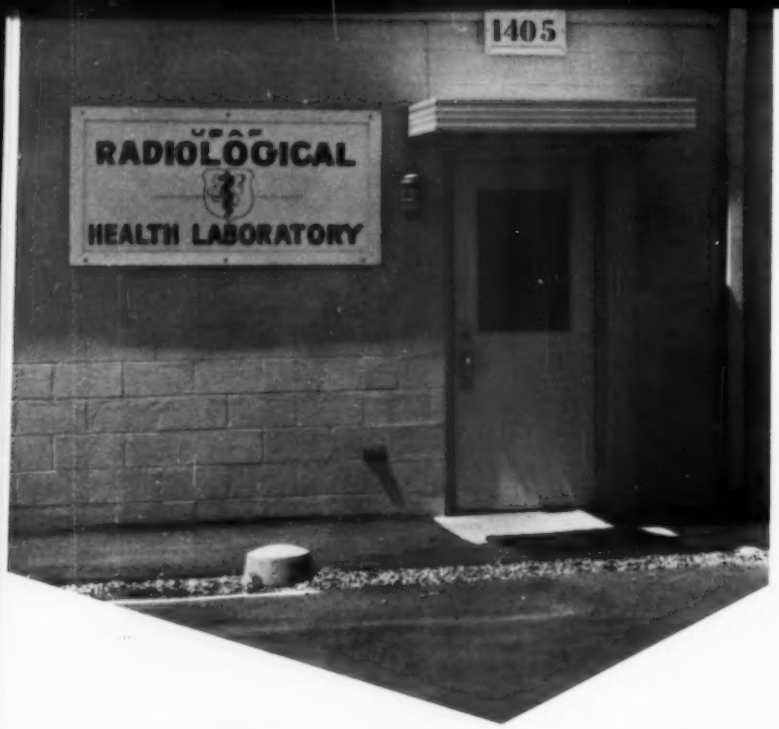
Photo Terrain Analysis

Send a Prime Beef Site Selection Team member.

A highly specialized course to teach photo interpretation techniques for site selection.

* New course in FY 73

ERING SCHOOL
-1973
OFFERINGS



For the BCE who has a pressing pollution problem, he can consult one of three . . .

Air Force Health Labs

by Lt Col Donald D. Higgins and Capt Andrew T. Hayden

Problem: Fish kill reported downstream from base "X" sewage outfall.

Problem: "Noxious odors" in work area at base "Y" making employees ill.

Problem: Shielding specifications needed for industrial x-ray facility at base "Z".

At first glance, these problems have nothing in common. Their solutions do have something in common, however—coordination between Base Civil Engineers (BCEs), scientists and engineers from one of three Air Force health laboratories (the U.S. Air Force Environmental Health Laboratories at Kelly AFB, Texas; McClellan AFB, California; and the Radiological Health Laboratory at Wright-Patterson AFB, Ohio).

To solve the fish kill problem, base "X" contacted the Environmental Health Laboratory at Kelly AFB since that lab specializes in water pollution problems. A team from the Lab analyzed the problem. In their evaluation of the stream and liquid waste effluents from the base, scientists and engineers indicated the fish were killed by pollutants from the base sewage outfall. A follow-on evaluation of the waste disposal system and treatment process revealed that the facilities were not adequate for treatment of liquid waste generated by the base and the effluent discharge into the stream did not meet state water quality standards.

What were the results of the study? The team recommended complete modification of the existing plant. Together, BCEs and Lab specialists worked out a pilot plant study to insure adequate treatment at minimum cost.

The problem at base "Y" was referred to air pollution specialists of the Environmental Health Lab at McClellan AFB. When employees at base "Y" complained of air pollution (specifically "noxious odors") in their work area, a call for help went to the McClellan Lab.

The Lab team sampled air quality throughout the facility at base "Y" for a period of three weeks. Analysis of the samples showed the air pollution was caused by nearby industrial plants, not by Air Force activities at base "Y".

In this case, team members recommended close cooperation with local air pollution control authorities. They also suggested that air sampling be continued until the situation was cleared up, and that in the interim employees be allowed to go home when the pollution index was high.

While the problems at bases "X" and "Y" demanded extensive on-site studies by lab specialists, the problem at base "Z" was more easily resolved. Plans called for a Nondestructive Inspection facility to be built at base "Z". The facility would use an industrial X-ray machine, and specifications were needed for shielding to protect workers from radiation.

In this case the obvious source of information was the Radiological Health Laboratory at Wright-Patterson. Working from the proposed plans, health physicists were able to supply specifications down to

and including the thickness of lead shielding for the walls and the position of air conditioning ducts. When the X-ray facility is completed, a health physicist from the Wright-Patterson AFB Lab will make an on-site radiation protection survey.

In addition to their speciality functions in air and water pollution, the Environmental Health Laboratories provide other services to BCEs. For example, toxicology specialists at Kelly AFB (who found the cause of the fish kill at base "X") investigate the effects of Air Force activities on animals and fish—useful information when a base is faced with claims for damage to animals.

The stack sampling team from the McClellan AFB Lab has evaluated base heating plants and incinerators for compliance with emission criteria of Federal and local air pollution regulations. The team, certified by the Environmental Protection Agency, is capable of making independent evaluations for compliance with air pollution criteria. These evaluations generally include determination of gaseous flow rates, concentration and size of particles, sulfur dioxide, nitrogen dioxide, dust collection efficiencies and total emissions into the atmosphere.

Equipment Measures and Evaluates

Both environmental labs are equipped with sophisticated equipment to measure and evaluate noise under almost any condition. Lab specialists use this equipment to assist BCEs in solving noise abatement problems. For example, they can recommend the best place to locate jet engine test stands and power check pads. Lab specialists now are working on a project to check noise levels in aircraft control towers. Environmental technicians also can advise civil engineers on how to comply with noise attentuation specifications written into contracts for construction projects.

For the BCE who has a problem with pest control, the environmental labs provide consultation and on-site services in entomology. Entomologists can identify pest species (on a limited scale), determine if plants are being killed by pesticide overdoses, determine insect resistance to pesticides and advise on the international quarantine program. Advice on how to control certain pests through environmental manipulation rather than the use of pesticides also is available. Surveys to evaluate base pest control programs are another service that can be provided by entomology specialists. Such surveys include a review of equipment, chemicals, procedures, manpower and safety.

A comparatively new area in which environmental specialists can help the BCE is in the preparation of Environmental Assessments and Statements to evaluate the impact on the environment of various Air Force activities and projects.

The assistance of the Air Force Environmental and Radiological Health Laboratories may be requested through the Director of Base Medical Services. Problems such as the fish kill on base "X" which require complex, on-site surveys must be cleared through major commands. Simpler problems, however, often can be solved by a letter or a telephone call to the lab concerned.

Early in the 1950s, the Air Force Surgeon General organized three small consultant groups to provide expert advice on environmental health to base level aerospace medicine programs. From these three groups grew the Air Force Environmental Health Laboratories and the Radiological Health Laboratory.

More recently—and since the Federal government has begun to take the lead in correcting pollution problems—specialists from the laboratories have become increasingly involved as consultants to BCEs on pollution problems.

The mission of each Environmental Health Laboratory is to provide specialized, analytical, biological and chemical analyses and consultative services in occupational health, bioenvironmental engineering, sanitary engineering, entomology and toxicology to Air Force installations.

The mission of the Radiological Health Laboratory is to provide consultation on the health effects of ionizing and non-ionizing radiation, radiation protection surveys, evaluation of equipment which produces radiation, and analysis of environmental samples for radiation. The Radiological Health Lab also provides a film badge service to workers whose jobs may result in exposure to ionizing radiation. In addition, the Air Force Radioisotope Committee, Air Force's liaison with the Atomic Energy Commission for the licensing of radioisotopes, is located at the Radiological Health Lab.

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Happiness is... RPIE That Runs

by CMSgt William N. Patton

Skilled technicians of the Aerospace Defense Command's (ADC) CEMIRT teams are on the alert as you read this article. CEMIRT is an acronym for Civil Engineering Maintenance Inspection Repair and Training. Their alert is not the scramble type operation normally associated with ADC. CEMIRT's watchfulness is necessary to keep selected Real Property Installed Equipment (RPIE) in such condition that it will sustain operation under various national emergency conditions. This includes diesel and turbine prime movers, alternators, air conditioners, switchgear, protective devices, overhead and underground distribution lines, intrusion alarms and associated systems.

CEMIRT mobile teams were initiated in 1959 when using commands became responsible for the depot level maintenance and overhaul of diesel generator units. At that time, teams were established at each air division headquarters. Each was given its own transportation fleet, and allocated a geographical area covering an approximate eight-state area. In July 1959 the teams were organized formally under the name RADEM, Radar Diesel Electric Maintenance. Considerable field experience gained during these early years enabled expansion of the services offered and gradually other categories of maintenance were added. As the air divisions changed, so did the teams, expanding and contracting as the needs of the Command fluctuated.

Team members from Otis AFB replace camshaft bearings on a diesel engine. Precision fit and quality are a must.

In 1962, the name was officially changed to CEMIRT and the teams were assigned under numbered air force control. In 1967, CEMIRT responsibilities and cost accounting, supply, budget and procurement procedures were outlined in the first CEMIRT manual. With this organizational setup, as under the air division organization, some teams operated much better than others. Standardization was still difficult, and response to emergencies outside a team's normal geographical area often required extensive coordination. A comprehensive study was then completed to determine how to bring individual teams to the same capacity levels.

During the summer and fall of 1969, it was decided to form the teams under direct control of the Command with each team operating in specified areas for all categories of maintenance. A CEMIRT Section was established at Headquarters ADC to supervise the operation. In January 1970, this organization became a reality and the teams were standardized as to size and disciplines.

CEMIRT functions well today because of the 10 years experience, lessons learned and changes made by many men during that time. Five teams are now in existence at these Air Force locations: Hamilton AFB, Malmstrom AFB, Otis AFB, Tyndall AFB and Duluth IAP. Each team is made up of an all-civilian crew which has been trained to accomplish depot level maintenance, inspection, repair and training.

Team chiefs report directly to the CEMIRT Section at Headquarters ADC. This Section, which consists of a civilian chief and a military NCOIC, monitors the Commandwide operations including dispatching technicians out of normal geographical areas. The teams normally operate as independent units, completing tasks on a scheduled basis as prescribed by

ADCM 91-9. Copies of their schedules are furnished to the CEMIRT Section. Unscheduled maintenance is reported to the CEMIRT Section on the next duty day and is plotted on a magnetic map. This permits quick spotting of any overworked areas or problem trends that might be developing. Each team is assigned to a host base for administrative purposes only, and thus, functions as any other tenant to budget, supply, procure, transport, administer, quarter and otherwise operate its individual team. When emergencies occur, CEMIRT team chiefs direct response in their areas. Extra help is obtained through a phone call to the CEMIRT Section at ADC.

During natural disasters or conventional air attacks, CEMIRT responds to emergency work required to keep mission essential equipment functioning. Nuclear attacks would also receive emergency response commensurate with radiation fields, travel limitations and communication restrictions. Such response would be directed by CEMIRT Section personnel who would respond directly to orders received from the Battle Staff Support Center (BSSC) located in NORAD Cheyenne Mountain Complex (NCMC). During advance stages of air attacks, when the CEMIRT Section could not be manned, the BSSC staff would control CEMIRT through direct communications with the CEMIRT chiefs. If communication with both the CEMIRT Section and the BSSC were lost, the CEMIRT chief would continue to direct response to emergencies where possible. Priorities would be based on common sense evaluation of problems.

Responsibilities Spelled Out

All five teams are responsible for maintenance on electrical power production systems. This work comprises the majority of CEMIRT's tasks. Diesel maintenance responsibilities include all depot level maintenance as outlined by **AFM 85-19,** Maintenance and Operation of Electric Power Generating Plants. These responsibilities are applicable to ADC bases, NCMC, radar and BOMARC sites. SAGE plants do their own depot level diesel maintenance, except that CEMIRT completes at least one 8000-hour diesel inspection annually. CEMIRT technicians thus maintain engine familiarity, should their assistance be required in emergencies. Alternator maintenance follows the same pattern of responsibility and compliance. CEMIRT has also been assigned certain critical items, such as crankshaft deflection adjustments, to insure standard and quality performance. The teams at Tyndall AFB and Hamilton AFB operate fuel pump and governor test facilities for the entire Command.

Certified electricians are assigned to all five teams. These technicians are responsible for switchgear maintenance as prescribed by **ADCM 91-12,** Maintenance of Electrical Protective Devices. This

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critical equipment must be properly maintained and adjusted if costly outages are to be avoided. Significant results have been achieved since this program began and numerous modifications have resulted from inspections made by these electricians. One of the most significant is rework of alternator circuit breakers to insure excitation cutoff on all protective device signaled trips except reverse power. New "at power" protective relay maintenance methods are constantly being developed.

Original packing, masking tape, loose springs, jumper wires and completely damaged devices are but some of the items discovered on routine inspections. Such defects are brought to the attention of staff engineers through the CEMIRT Section, and on-the-spot corrections are made by the CEMIRT tech-

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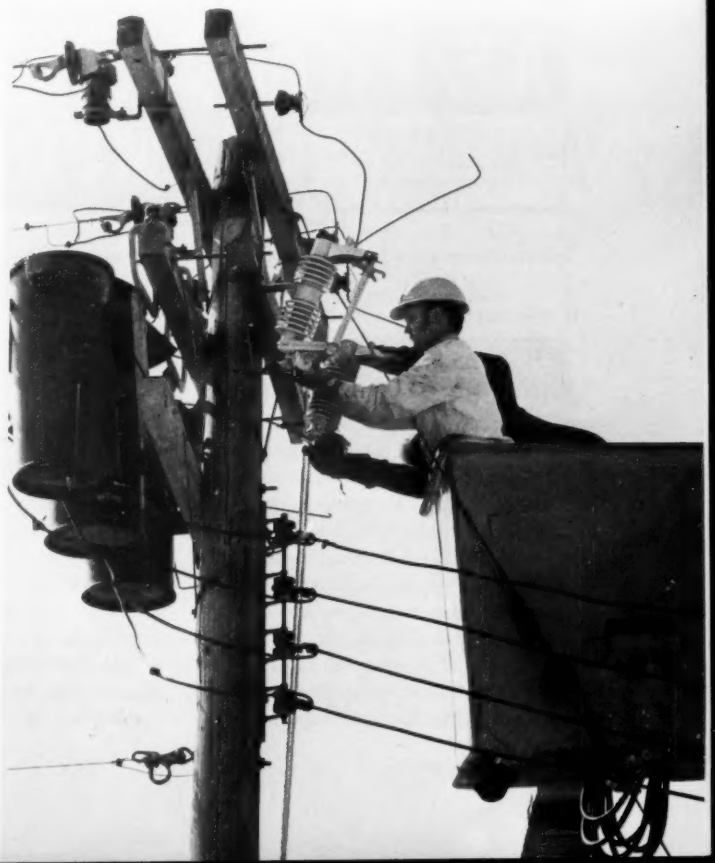
Duluth IAP team members install new fuse cutouts on an overhead line. Linework is a new CEMIRT responsibility.



Happiness is... RPIE *cont'd*

nicians. Other technicians also receive the same reports via manual revisions so that a Command-wide technical information service is achieved. Information has been supplied to the U.S. Army, U.S. Navy, other major commands and other government agencies. This service exists with all the maintenance categories.

CEMIRT electricians also make quarterly inspections of selected intrusion detection alarm systems. Since this program began there has been a significant drop in the number of problems with these systems resulting in increased security.

Air conditioning depot level maintenance is another assigned CEMIRT responsibility. These jobs range from small compressors to replacement or repair of entire systems. Annual visits are made to accomplish this work. Temperature, humidity, controls, instruments, air volume, pressures, safety devices, oil and refrigerants are some of the major parameters checked.

Overhead and underground line work is the newest of CEMIRT responsibilities. This work is done at radar and BOMARC sites only, and has already resulted in numerous innovations with significant savings over contract costs.

Maintenance training is another important CEMIRT function. The idea here is to train site personnel to do as much of their own work as possible. While mission requirements seriously limit operational training, CEMIRT technicians are capable of training when opportunities exist. This is especially important when improper operating techniques are resulting in severe maintenance problems. CEMIRT technician training is a continuing process so that personnel remain current with changes in the state of the art.

While the general assigned areas of responsibility are normally followed, CEMIRT's greatest asset is its flexibility. This means nationwide coverage of ADC installations in the minimum possible time. CEMIRT supplements its work force by certifying qualified station personnel to do specified depot level tasks. This requires training programs on the equipment involved and special training seminars where local problems dictate.

CEMIRT's main goal is to keep the equipment running. This is accomplished by being as self-sufficient as possible; by developing standard quality work methods; by training station personnel to supplement the CEMIRT work force; and by scheduling necessary work to minimize emergencies. In ADC, civil engineering has found better ways to keep its equipment running more efficiently. At ADC, happiness is RPIE that runs!

AF/PR EMPHASIS

(Information contained in this department of the Journal is provided by the various Divisions that make up the Directorate of Civil Engineering. It is intended to keep personnel at the Base Civil Engineering level informed of actions at Headquarters U. S. Air Force.)

MANAGEMENT DIVISION

Recent DoD guidance necessitates the establishment of new cost account codes. The codes have been reworked to provide greater flexibility; therefore, many codes and descriptions have changed. Also, the categories of Housing have been changed and expanded. These changes will be effective 1 July 1972. All BCEs should insure that the AFM 300-4 changes are reviewed prior to the beginning of the new fiscal year, in order that costs may be properly charged.

PLANT ENGRG DIVISION

The basis of finish schedules for walls, ceilings and floors in AFM 88-15, Design Criteria and Standards, is DoD's manual. A major revision now drafted by DoD proposes to eliminate the detailed schedules and allow use of various materials based on considering life cycle cost, fire and safety requirements. Only exception would be that carpets would require specific approval by DoD.

• • •

OSD has authorized the Air Force to accomplish $44.9 million in design and construction projects in the FY 73 MCP. This consists of 65 projects for design and 52 projects for construction supervision which involve nine major commands and 41 locations in the United States. Although conventional methods will be employed in most cases, new and innovative techniques will be explored in others, presenting a challenge to Air Force engineers at all echelons.

REAL PROPERTY MGNT

Surveys of real property, under the provisions of Executive Order 11508, have been accelerated as outlined in AF/CVA ALZICOM

message 009/72 171901Z. OSD survey teams will visit 43 installations and Air Force teams will visit 51 installations by 30 December 1972. These are in addition to those surveys made by the General Services Administration. The importance of being prepared to justify all land required to support the mission of the installation cannot be overemphasized. A revised AFR 87-22 concerning this subject will be published in the near future.

ENVIRONMENTAL PROT

Accidental oil and hazardous substance spills are receiving increased attention by Federal officials charged with enforcement of pollution laws. AFR 91-1 requires commands to develop emergency plans to deal with accidental pollution. The Civil Engineering Center is developing detailed guidance for the preparation of these plans with forecast distribution to commands and bases in the spring of 1972.

PROGRAMS DIVISION

The call for submittal of FY 1974 MCP which was submitted to commands in late February contains several departures from procedures from prior years. Initial selection of projects was not made at Hq USAF level, but a dollar level was established for each command submittal generally related to that command's share of the Air Force total facility deficiencies for FY 1974 (approximately $1.1 billion), as reflected in the 1971 4-HAF-Z17 report prepared by the major commands. The dollar total of submittals from the commands is expected to considerably exceed the anticipated fiscal ceiling for this construction program. In the ultimate composition of the FY 1974 MCP, there will be an attempt to assign dollar limits to major commands or the functional categories of facilities. The final program will consist of projects which, regardless of location or functional category, are judged to best support the overall mission of the Air Force. In this environment, DD Forms 1391, 1391c and other supporting documentation prepared at base and command level will determine, to an even larger degree than in the past, the ultimate disposition of projects.

* * *

The publication of AFM 86-1 is now forecast for sometime this month. Delays have been encountered in incorporating the rapidly changing policies with respect to delegation of approval authority for projects and the need for substantial editing to incorporate the improvements suggested by commands. The new manual will include approval authorities and procedures for all civil engineering programs avenues.

The FY 1972 Military Construction Authorization Law (PL 92-145) establishes a special programming avenue for cost saving minor construction projects. The law provides that projects otherwise qualified for the minor construction program can be approved without a certificate of urgency provided the construction " . . . will within three years following completion of the project, result in savings in maintenance and operations costs in excess of the cost of the project." This means that construction projects costing up to $300,000, which within three years after completion, will save operation and maintenance costs in excess of the cost of the project, are eligible for special consideration. Present value of savings and costs computed in accordance with AFR 172-2, 30 December 1969, must be used to determine eligibility.

CE CENTER

Base Development Planning in support of Joint Contingency Operations is an Air Force Civil Engineering responsibility. Command Civil Engineers must insure that civil engineering forces, primarily crash/rescue firefighters, runway barrier installation teams and utility operation personnel are correctly identified in the appropriate force listing of contingency plans. In accordance with the Joint Operations Planning System, each Operations Plan or Command Support Plan must contain a Base Development Plan listing airfield facility assets, requirements and deficiencies in the prescribed format.

* * *

Amendment 35 to AFM 67-1, Volume I, Part One, Chapter 11, Section M, dated 24 January 1972, provides updated procedures for support of RED HORSE squadrons. This change includes the concept of operation, responsibilities for supply support, and supply procedures for overseas deployment. MAJCOMS which have RED HORSE squadrons assigned and the squadrons themselves should become familiar with all aspects of this change.

* * *

During visits by Aircraft Crash Rescue Field Assistance and Evaluation Teams, it has been observed that fire departments have not developed lesson plans for recurring/proficiency training. Properly developed lesson plans are necessary as they provide the instructor with the tools to insure meaningful and adequate training. In developing lesson plans, the following goals should be accomplished: 1) realistic objectives; 2) continuity and standardization of training; 3) logical sequencing of subject material; 4) goals trainee is expected to achieve. Lesson plans also provide the instructor with an outline which helps assure complete coverage of the training subject. Additional information and guidance can be obtained from AFM 50-9, Chapter 15 through 19.

Construction Management *and* Management Science

by George C. Windrow, PE

Progress in the construction industry over the past several decades has been measured by compressed construction times, proliferation of exotic materials and complexity of building systems. Each improvement has required a corresponding improvement in the skills and management techniques used by the engineer in charge of construction. This has required an increase not only in the quality of the engineering disciplines but also an increase in the contribution of other academic fields.

Substantial contributions to the construction field have been made by the area of study known as decision theory, interwoven with aspects of operations research, and collectively known as management science. While the engineering disciplines contributed directly to the amount of information available, the application of management science is concerned solely with organizing the available information into a system for the selection of a particular course of action.

Basically, management science is a decision-making process that takes into consideration a set of alternatives and then, selection of the best alternative to achieve a goal or objective. To prevent conflict between objectives, and frequently to identify the best objective, the possible outcomes must be expressed in terms of a common dimension. The questions which must be answered for each system are: What are the controllable variables? Which variables are uncontrollable and what are their values? What is the relationship between the inputs and outputs? And finally, what is the objective of the decision?

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Management science has contributed substantially to the successful execution of a major military family housing alteration and modernization project at Langley AFB, Virginia. The project involved the upgrading of 234 pre-World War II housing units. Although the units could not be economically duplicated on today's market, they were in serious need of maintenance and modernization. Inflation, redesign and funding problems had delayed the project until it was obvious that the appropriation could not cover all of the work and further delay would allow project approval to expire. However, in June 1969, bids were solicited on 178 units. Since the units were occupied quarters, the complexity of the management problems is highlighted by consideration of **Chart I** which shows a varying number of 12 different type units with different bid prices for varying amounts of work in two categories.

The construction contract was written in delivery order format and guaranteed the contractor a minimum of 20 units. Although it was apparent that all units could not be completed within the project approved amount, the Family Housing Division at Headquarters U.S. Air Force agreed to proceed with construction with the objective of completing the maximum amount of work within the funds available. To accelerate the project, it would be necessary in some instances to relocate occupants. A study group was established to analyze the project and recommend courses of action.

The first step was to clarify objectives based upon the controllable variables. First, projected vacancy rate was obtained from the housing office for each type unit and then the bid results by type unit were arrayed as shown in **Charts II and III.** The alterna-

cont'd on page 28

Chart I: Unit Cost Based on Bid Prices by Type Unit and Type Work — June 1969.

TYPE	NR	P-722 PH 1	P-722 PH 2	P-713 ALT	SIOH/C	UNIT COST
1A	71	654	4,700	3,258	258	$8,870
1B	20	970	5,200	3,528	258	9,956
2A	2		6,280	1,318	258	7.856
2B	8	600	7,450	1,318	258	9,626
2C	15	600	5,920	1,318	258	8,096
2D	3	600	5,470	1,368	2587	7,696
2E	1		5,740	868	258	6,866
2F	1	600	4,570	868	258	6,296
3	38	600	7,900	790	258	9,548
		600	7,900	918	258	9,676
4	9		5,470	1,998	258	7,726
5	4		5,470	1,278	258	7,006
7	4		2,590	3,298	258	6,146
TOTAL COST			$586,789	$1,500,000		
APPROVED			417,100	1,220,100		
DEFICIT			-169,698	-279,900		

TYPE	RATE	NO	MAX CUM	MIN CUM	UNIT COST	MAX CUM COST	MIN CUM COST
III	$7900	38	38	178	$300,200	$300,200	$1,021,662
II B	7540	8	46	140	60,320	360,520	721,462
IICB	7201	2	48	132	14,402	374,922	661,142
II A	6280	2	50	130	12,560	387,482	646,740
II C	5920	15	65	128	88,800	476,282	634,180
II D	5470	3	68	113	16,410	492,692	545,380
II E	5470	1	69	110	5,470	498,162	528,970
IV	5470	9	78	109	49,230	547,392	523,500
V	5470	4	82	100	21,880	569,272	474,270
I B	5200	20	102	96	104,000	673,272	452,390
I A	4700	71	173	76	333,700	1,006,972	348,390
II F	4570	1	174	5	4,570	1,011,542	14,690
VII	2530	4	178	4	10,120	1,021,662	10,120

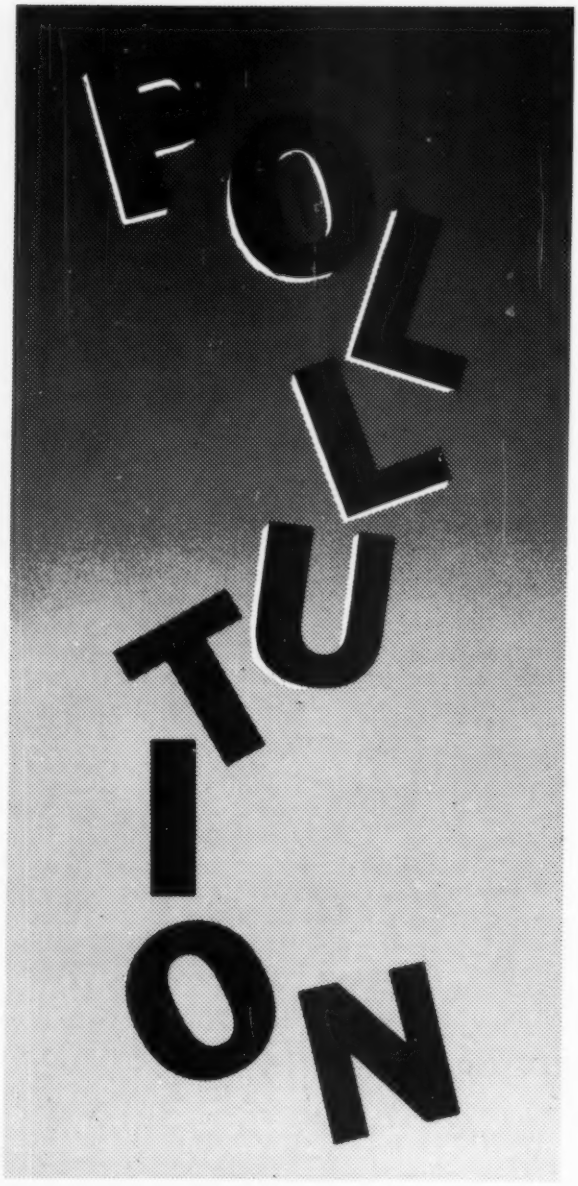
$943,500 available
943,500 - 721,462 = 222,038
222,038 _ 7900 = 28.1
140 +28 = 168 units

Chart 2: P-722 Cumulative Cost by Type Unit.

Chart 3: P-713 Cumulative Cost by Type Unit.

TYPE	RATE	NO	MAX CUM NO	MIN CUM NO	UNIT COST	MAX CUM COST	MIN CUM COST
IB	3400	20	20	178	$68,000	$68,000	$393,143
VII	3170	4	24	158	12,680	80,680	325,143
IA	3130	71	95	154	222,230	302,910	312,463
IICB	1915	2	97	83	3,830	306,740	90,233
IV	1870	9	106	81	16,830	323,570	86,403
II D	1240	3	109	72	3,720	327,290	69,573
II A	1190	2	111	69	2,380	329,670	65,853
II B	1190	8	119	67	9,520	339,190	63,473
II C	1190	15	134	59	17,853	357,043	53,953
V	1150	4	138	44	4,600	361,643	36,100
III	790	38	176	40	30,020	391,663	31,500
II E	740	1	177	2	740	392,403	1,480
II F	740	1	178	1	740	393,143	740
		178					

$287,500 available
287,800 90,233 = 197,567
197,567 3,130 = 63.12
83 + 63 = 146 units



ABATEMENT in Aerospace Defense Command

by Loy A. Callen, PE, and Ervin J. Bedker, RLA

Aerospace Defense Command (ADC) has used many approaches in implementing pollution control standards of public law and executive order. Air and water pollution projects totaling $4.2 million were programmed for FY 71 and FY 72, and an expenditure of $3.3 million is planned for FY 73 to meet the President's "underway by 31 December 1972" requirement.

One of the greatest challenges at ADC has been anticipating and meeting changing state and local standards. Mill Valley AFS, California, is an example. Located in a municipal watershed, two miles from the Lake Alpine reservoir, its primary and secondary sewage treatment along with post-chlorination provided excellent quality effluent for several years. In April 1968, a representative of the San Francisco Water Quality Control Board informally stated that the Board would permit no effluent on the watershed, regardless of quality. Subsequently, the Board made other requests for minor changes to the facilities which were immediately complied with, but no further mention was made of the "no discharge" requirement.

Two years later, the Board obtained a hearing at which the Air Force was to show cause why a cease and desist order should not be issued. During the hearing, ADC engineers proposed tertiary treatment as an alternate to the "no discharge" requirement. The Board accepted the proposal. Subsequently, ADC engineers completed an $85,000 project which consists of chemical flocculation followed by tube settlers and mixed media filtration. Now, the effluent from Mill Valley AFS is essentially of drinking water quality.

Similar problems which have occurred at other ADC installations have emphasized the need for a policy of maintaining continuous and close liaison with federal, regional, state and local agencies. The more in advance ADC anticipates changes to air and water quality standards the less costly it will be in terms of programming and project accomplishment. In line with this concept, ADC has planned an air pollution abatement project at the NORAD/Cheyenne Mountain Complex even though existing standards are met.

ADC has levied specific pollution abatement requirements in a supplement to **AFR 161-22.** At Headquarters ADC, civil engineering has been designated the office of primary responsibility for pollution control and environmental protection objectives. An Environmental Branch was established which devotes its full effort toward environmental enhancement. It insures that ADC budget estimates, funded programs, and plans and specifications provide for environmental pollution control consistent with Air Force requirements. In addition, the Branch coordinates each air and water pollution control project with the appropriate office of the Environmental Protection Agency.

A Headquarters ADC Environmental Protection Committee has also been established. Chaired by the DCS/Civil Engineer and with representatives from

all ADC staff agencies having a responsibility, the committee provides broad organizational and individual support for environmental enhancement. The committee has met at least quarterly since November 1970 to consider numerous matters ranging from overall command environmental programs to specific problems at individual installations. It selects nominees for the annual General Thomas D. White and Secretary of Defense environmental protection and natural resources conservation awards. It has also implemented procedures for preparing environmental assessments and impact statements for future ADC actions that might adversely affect the environment. The committee also participates in field visits to evaluate pollution abatement programs of individual installations.

Environmental protection activities are not limited to the command headquarters. In fact, individual installations play the key role in solving environmental problems. In ADC, it is required that each base commander appoint a coordinator to assure full cooperation in the program, coordinate actions, and prevent duplication of effort on pollution control matters. Further, the coordinator assures that officials who conduct operational and training programs resulting in emission of pollutants into the atmosphere—such as open fires for fire fighting training—exercise restraint consistent with meterological conditions and operational training requirements.

Base and station commanders have established an environmental protection committee to coordinate environmental matters that affect the installation and surrounding community. Bi-monthly meetings of the base committees are held to coordinate various staff actions. Their function includes assisting the commander in control of pollution by analyzing the effect of noise and electromagnetic energy as well as conventional pollutants. The committee must consider the impact of aircraft, boats, ground equipment, etc., having an adverse effect on the environment. Committees at ADC radar stations, although reduced in structure, have the same responsibilities as base committees.

To sharpen the focus on environmental protection, ADC installations are evaluated and compared for effectiveness. Inspector General inspections and Facilities Programming Panel visits have emphasized the urgency of environmental enhancement.

ADC uses the Civil Engineering Management Review Program as a means of attaining specific goals. Each installation, in order to meet the established goals, must conduct studies of at least four major waste generators each year in an attempt to reduce the waste of each generator. An example is Hamilton AFB, California, where purchase of a wood chipping machine has resulted in the creation of valuable mulch from tree trimmings, whereas the limbs formerly clogged the sanitary land fill.

Another example of the pollution is noise, especially that of the jet engine. Not only is such noise a nuisance, it can also cause serious injury to personnel. The risk of damage to hearing is slight when the noise level does not exceed 85 decibels for an eight hour period; yet, an engine runup can reach a noise level of 140 to 150 decibels. This level, unabated, will cause injury to hearing and, possibly, organic damage to the body.

The most effective and least expensive method of reducing noise is to provide distance between the noise source and the receiver. To the maximum extent possible, engine test facilities and runup areas are being placed where noise will be least dangerous to base personnel and the surrounding community. ADC requires commanders to have continuous and comprehensive educational programs to insure that personnel working in high noise areas wear protective devices such as muffs, ear plugs, disposable inserts and helmets.

In addition to the noise factor, electromagnetic energy, pesticides, solid wastes, air and water pollution constitute a myriad of problems for which ADC is implementing solutions and providing educational programs to create individual concern. Although environmental protection has received attention and discussion for several years, there is still a great need for positive action.

Success requires every organization and individual to actively support the program. Pollution control and abatement will test every commanders ability to rally his people in support of a program of national concern. It will measure the capability of the Base Civil Engineer to initiate and effectively conduct a complex program which extends beyond his normal responsibility.

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Closed Cycle Diesel Power-Psychrocycle

by Charles B. Totten, PE

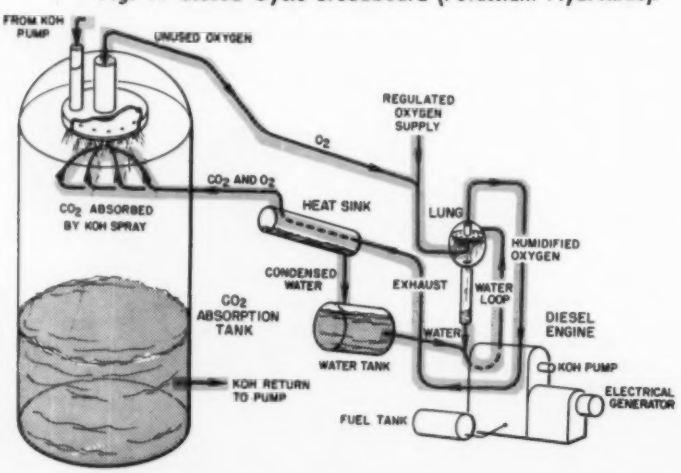
A method of operating a diesel in a closed environment was recently tested under a Space and Missile Systems Organization (SAMSO) contract with Aerojet General Corporation of Azusa, California. The contract was one of several awarded by SAMSO to investigate electrical power sources for advanced ICBM missile systems. Specific attention was given to the power range from 8 to 20 KW, as required by the Hard Rock Silo Program.

A power system which could operate independent of the above ground environment was considered highly desirable for advanced missile systems because of the severe overpressures and associated debris resulting from a hypothetical nuclear weapon near miss. After studying the problem SAMSO determined that several types of proposed power systems had potential for development. One such system selected for further analysis and advanced testing was the Aerojet diesel generator concept which breathed a synthetic "air" comprised of a mixture of oxygen gas and water vapor. The concept was termed psychrocycle.

Sporadic attempts by several countries, over two decades, had failed to develop a simple, efficient and practical way to operate a diesel in a closed environment. Engineers from SAMSO and Aerojet, working as a team, developed a closed cycle operation utilizing the psychrometric properties of a water vapor/-oxygen mixture to automatically regulate the mixture ration of the charge inducted into the engine. The psychrocycle diesel makes use of the following principles to achieve closed cycle operation.

- In proper proportions, water vapor in a mixture of water vapor and oxygen plays the same role as the nitrogen portion of the air does with respect to limiting combustion temperatures, burn rate and ignition point, and is the major "working fluid" component in a conventional air breathing diesel engine.
- By operating a diesel, oxygen rich formations of CO, carbon (soot), aldehydes, and other byproducts resulting from incomplete combustion are reduced or eliminated. Combustion product constituents consist of only CO_2, H_2O, O_2 and miniscule traces of other species.
- Operating with water vapor and oxygen, the diesel exhaust flow, mostly steam, is largely condensable allowing inherent isolation of the other combustion product constituents.
- By condensing the water, and, by chemically absorbing the carbon dioxide and returning any unconsumed oxygen to the engine induction flow, the cycle becomes closed.
- In this manner, the psychrometric properties of a water vapor/oxygen mixture are used to automatically maintain the oxygen-to-fuel ratio within the limits required for producing an exhaust suitable for the closed cycle process.

Fig. 1: Closed Cycle Breadboard (Potassium Hydroxide).



Probably the most successful initial attempt to develop a closed cycle diesel was accomplished by the Germans during the latter part of World War II. They tested a closed-cycle system (Kreislauf—meaning closed ended) for submarine engines that permitted operation without access to the atmosphere, as was required for snorkeling. After the war, from 1946 to 1952, the Internal Combustion Laboratory of the U.S. Naval Engineering Experiment Station at Annapolis, Maryland, (later MEL), continued the work and demonstrated the use of the Kreislauf system with U.S. Navy diesel submarine engines. The project was shelved with the advent of nuclear powered submarine propulsion.

The Kreislauf method of diesel operation recycled exhaust gases from the engine exhaust manifold back to the engine intake manifold after proportionately blending it with sufficient, added oxygen, to support combustion of the injected diesel fuel within the cylinder. On shifting from surface operation to Kreislauf operation, the induction working fluid changed from air to oxygenated carbon dioxide. After exhaust from the engine, the gases were cooled, condensing out the water formed by combustion. To obtain a constant operating pressure and material balance in the loop, the excess oxygen, water and carbon dioxide were continually pumped overboard

against the sea water pressure. Since products were pumped overboard the term "kreislauf" is actually a misnomer in that the cycle was not really closed. Several hundred horsepower were required to pump the products overboard at a four-hundred foot submergence depth.

The Kreislauf method required large volume gas flow rates resulting in bulky gas coolers, regulators, a gas cleaner and the overboard exhaust pump. Continuous monitoring of the gas constituencies for mixture ratio control was required with separate analyzers for CO_2, O_2, and CO, as well as an oxygen/fuel proportioner. These subsystems were used in conjunction with the many associated sensors, regulators and compensation input transducers to maintain the oxygen-fuel ratio near a prescribed ratio.

By comparison the psychrocycle diesel system is truly a closed cycle with constant buoyancy possible. It operates with the major through-flow being condensable water vapor and excess oxygen, which is recirculated, resulting in relatively small piping and components. The entire operation tends to be self regulating with simple control by a conventional pressure regulator and an engine speed governor.

Successful demonstration of the psychrocycle diesel power system operating on several oxygen sources and carbon dioxide absorption methods has been accomplished with breadboard systems operating for a total of over 100 hours at Aerojet's Azusa plant. Closed cycle operation was smooth, stable and considerably quieter than air breathing operation. The breadboard power system shown in **Figure 1** utilized a conventional, unmodified 2-stroke diesel engine and an off-the-shelf electrical generator. A 16-inch diameter spherical lung chamber (humidifier) was mounted above the engine intake. Engine exhaust is discharged through a heat exchanger where water vapor is condensed by cooling. The water is drained into a tank where it is made available for use again in the coolant loop. The exhaust gas out of the heat sink enters a carbon dioxide absorption tank where the carbon dioxide is absorbed by chemical reaction in a spray of potassium hydroxide to form a liquid potassium carbonate solution. The unused oxygen is recirculated to the lung.

The basic system, therefore, consists of a coolant water loop and an induction/exhaust gas loop. Each is self-regulating with respect to temperature, pressure, liquid levels and mixture concentration. Regulating devices are not required. The water loop is circulated by the engine water pump and the gas loop is circulated by the engine at pressures near atmospheric.

The engine used in the breadboard systems is a Model 2-53 made by General Motors Detroit Diesel. The electrical generator is a Delco unit which provides power to a controllable test load. Full operation of the system was accomplished from a remote control panel including startup, shutdown and load setting.

The alkali metal superoxide of potassium has the combined capacity for both liberation of oxygen and

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absorption of carbon dioxide. This capability was used to simplify the Closed Cycle Diesel providing compactness and light weight while retaining the basic simplicity of design. After completion of testing, using the breadboard configured as shown in **Figure 1,** the system was modified from gaseous oxygen/potassium hydroxide operation to use potassium superoxide (KO_2) canisters as shown in **Figure 2.** The engine breathes a mixture of oxygen, water vapor and carbon dioxide in the intake for combustion with the fuel. Combustion in the engine is essentially identical to that in air-breathing operation except water vapor replaces nitrogen as the inert constituent. The chemical reaction of combustion can be approximately described as:

$$CH_2 + 3/2\,O_2 \longrightarrow CO_2 + H_2O + \text{heat.}$$

The exhaust consists of CO_2, O_2 and water vapor. Latent and sensible heat is removed from the exhaust gas by the heat exchanger. The water vapor is condensed and then drains into the storage tank and the remaining gases flow forward to the by-pass valve.

The by-pass valve controls the proportioning of gas flow through the KO_2 bed to maintain the gas loop within a narrow pressure band slightly above atmospheric pressure (less than 1 psig). If loop pressure increases due to over-production of oxygen, the valve proportions less flow through the KO_2 bed to increase the oxygen generation rate. As the gas mixture flows through the bed of solid KO_2 granules, the CO_2 and water vapor react chemically with the KO_2. The reaction releases oxygen gas and gradually converts the solid KO_2 granules to solid potassium car-

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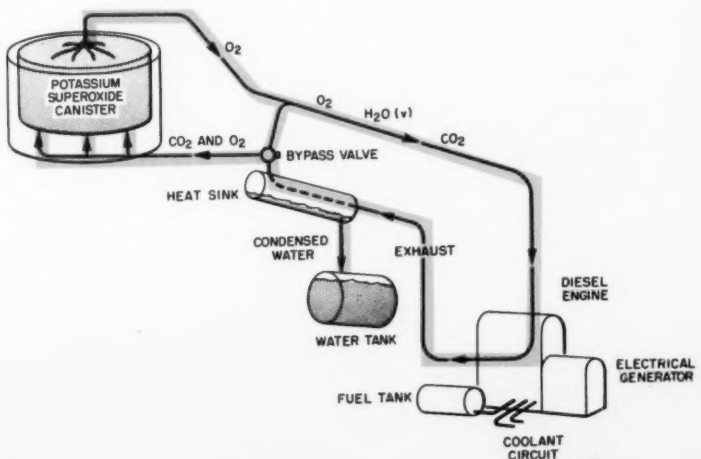
Fig. 2: Closed Cycle Breadboard (Potassium Superoxide).



Diesel *cont'd*

bonate (K_2CO_3) in a solid-solid diffusion process which is approximated by:

$$2KO_2 + CO_2 \longrightarrow K_2CO_3 + \tfrac{3}{2}O_2 + \text{heat.}$$

The oxygen gas evolved from the granules mixes with the through flow of excess oxygen and passes to the engine where the gas loop is closed. Circulation in the gas loop is maintained at constant volume flow rate by a scavenging blower which is a part of the engine.

Combining the combustion and the KO_2 reaction equations, an overall equation results which approximates the conversion of storage consumables to storable products:

CH_2	+	$2\ KO_2$	$\longrightarrow$	K_2CO_3	+	H_2O
(liquid fuel)		(solid granule)		(solid granule)		(condensed water)

A series of tests were conducted to demonstrate feasibility and practicality of using superoxide. The test program successfully demonstrated stable and efficient operation under various loads up to full power. The system was started and stopped under ambient conditions and after reaching steady state operation. The system was operated open cycle (conventionally), semi-closed (induction closed-exhaust open) and fully closed. Fuel consumption was normal for the engine used with little difference noted under the various modes of operation. Jet fuel (JP-5) was used in the tests because it is a relatively clean burning fuel suited to closed cycle operation after long storage.

The excellent results from the breadboard test program portend additional interest in the psychrocycle diesel. It is a system which can be built with readily available low cost components. Any further development of the concept should center on the chemistry of the superoxide reaction with emphasis directed to long duration runs of the system with intermediate standby periods introduced. The storability of superoxide over long time periods needs to be investigated. The KO_2 bed and the gas passages through the bed should be optimized to obtain full utilization of the oxygen contained with the KO_2. The engine used in the breadboard configuration using KOH was disassembled and no deletorious conditions were found; however, corrosion could be a problem under long term storage or use, and it should be factored into any further developmental work.

There are many potential uses for the psychrocycle concept. Submersibles engaged in undersea exploration, search and rescue, transportation, and construction, would be logical applications. Other areas where air is not available, or where atmospheric contamination by exhaust may not be permitted, are undersea habitats, hardened missile launchers, personnel shelters, communication centers and mining operations.

Aerojet General Corporation has applied for a patent covering the salient features of the psychrocycle with a confirmatory license granted for government use of the concept.

Management *cont'd*

tives were: (1) Maximum expenditure of funds with occupant moves and minimum number of units completed; (2) Completion of maximum number of units with high rate of occupant moves and delayed contract completion; (3) Complete the maximun number of NCO quarters (Type IA and IB) and complete other units as they become vacant by attrition. The analysis shown on **Charts II and III** is for maximum number of units completed and is made by reading "Min Cum Cost" column from bottom to top. For maximum expenditure/minimum units read down "Max Cum Cost" column.

Presentation of the facts and alternatives to the Base Commander resulted in the determination that work would concentrate on the NCO quarters with other units accommodated as they became vacant. In addition, approval was obtained to modify the contract to increase the units under work or readvertise as required.

With the objectives and primary courses of action identified, the study group was now in a position to prepare a PERT Chart to analyze the flow of units, performance times and lot size. During the preparation of the PERT Chart, it became apparent that 30 units must be under work at all times, 15 units was the optimum lot size for management, and an additional contract would be required. Although no true critical path emerged, the chart did identify the activity-time sequence for the Base Civil Engineer, Procurement, Housing Officer and the Transportation Officer. For example, work started on vacant units, the Housing Officer had a check for forecast vacancies, the Transporation Officer could note when "Move Occupant" was required and the Procurement Officer had a key for delivery of purchase orders by unit. The contractor in turn was able to schedule his work and materials by construction trades by unit.

Subsequent contracts produced a reduction in bid prices. This, coupled with contract modifications, increased the funds available for work on additional units. At the present time, work is nearing completion on this project and only 18 units will remain for upgrading in future programs.

Management science was a major factor in successful accomplishment of this project. Each step (diagnosis and analysis identification of inputs and payoffs, construction of the model of the system and selection of the optional courses of action) contributed directly to project completion.

worth noting

Equipment Advisory Group Holds Conference at Luke AFB, Arizona

Col Frank G. Barnes, DCS/Civil Engineering, Hq TAC; Lt Col Jack E. Doty, Chief, Equipment/Materials Branch, CEC; and Robert E. Brandon, Associate Director, CEC, review the GEEAC program prior to the start of the semiannual conference.

The Air Force Civil Engineering Equipment Advisory Group (CEEAG) held its semiannual conference at Luke AFB, Arizona 8-10 February 1972. The conference was hosted by the Tactical Air Command and chaired by the Director, Civil Engineering Center. Approximately 60 persons, representing all major air commands and several Air Staff agencies, were in attendance.

The CEEAG identifies and evaluates civil engineering equipment problem areas, determines appropriate corrective actions, and provides guidelines for problem resolution. It represents the collective civil engineer in the Air Force as manager of equipment, including the development, procurement, production, evaluation and utilization of that equipment.

Museum Named An Outstanding Engineering Achievement in 1971

The Air Force Museum at Wright-Patterson AFB, Ohio, was named one of the 10 Outstanding Engineering Achievements of 1971 by the National Society of Professional Engineers (NSPE). The announcement was made in Washington D.C., in conjunction with the 22nd annual observance of National Engineers Week, February 20-26.

In making the announcement, the NSPE referred to the Museum as "a tribute to the engineering profession. The Museum portrays the evolution of the profession—from Da Vinci's research to man's exploration of outer space. Dedicated by President Nixon in September 1971, the new Museum is located on a 400-acre site and focuses on the history of the U.S. Air Force and some of the outstanding engineering accomplishments of all time."

The nine other engineering achievements singled out by NSPE are: the California State Water Project; the SF6 Gas Insulated Systems; the San Juan-Chama Water Project, Rio Grande Basin, New Mexico; STARAN, a new computer which can predict potential conflicts between aircraft in a 4,000 square mile area with sufficient warning time to pilots; a new Sulfur Recovery unit that contributes to clean air by removing over 97 percent of the sulfur from refinery fuel gas; the Chicago Northwest Incinerator; the Bruckner Interchange, Bronx, New York; the Chicago Area Expressway Surveillance; and the TWA Total Energy Plant.

Fire Box

FIRST HALF—FISCAL YEAR 1972
(1 JULY TO 31 DEC 1971)
USAF REAL PROPERTY FIRE LOSSES

COMMAND	NO. FIRES	USAF $ LOSSES
AFAFC	0	0
AFCS	1	0
AAC	5	44,838
ACIC	0	0
ADC	16	42,720
AFLC	19	3,126
AFRES	0	0
AFSC	17	2,093
AFSC (IP)	1	124,934
ATC	36	86,256
HQ COMD USAF	2	117
MAC	20	132,556
SAC	84	40,246
TAC	23	64,490
USAFA	0	0
USAFSS	4	720
USAFSO	1	171
USAFE	11	19,305
PACAF	7	3,754
AU	2	409
TOTAL: 20	249	$524,489

SCI & TECH
MAY 24 1972

National Engineers Week

Awards Presented to Five AFCEs

Award presentations to five members of the Air Force Civil Engineering family highlighted the Air Force Civil Engineering Day luncheon on 23 Februray in tribute to National Engineers Week. The luncheon was sponsored by the Directorate of Civil Engineering and was held at the Officers Open Mess, Bolling AFB, Maryland, with over 300 persons in attendance.

The 1971 award winners are:

- 1st Lt James M. Owendoff, NORAD Cheyenne Mountain Complex Section, DCS/Civil Engineering, Headquarters Aerospace Defense Command, Ent AFB, Colorado, Meritorious Achievement Award for Professional Excellence (military);
- Neil Rochelle, Base Civil Engineering, 1st Composite Support Group, Andrews AFB, Maryland, Meritorious Achievement Award for Professional Excellence (civilian);
- Brig Gen John D. Peters, DCS/Civil Engineering, Headquarters Air Force Systems Command, Andrews AFB, Maryland, Best Author Award;
- MSgt Abe Joiner, NCOIC Operations Unit of the Heating Section, 3415th Civil Engineering Squadron, Lowry AFB, Colorado, Non-Commissioned Officer of the Year Award; and
- Joseph F. Lynam, Foreman, Housing Maintenance Section, 438th Civil Engineering Squadron, McGuire AFB, New Jersey, Foreman of the Year Award.

Maj Gen M. R. Reilly, Director of Air Force Civil Engineering, presented the awards to Lieutenant Owendoff and Mr Rochelle. The 25-year-old Lieutenant was cited for his outstanding qualities of character and judgement in the accomplishment of his assigned duties as a mechanical engineer responsibile for the mechanical design and construction of the new utility plant under the FY 70 Military Construction Program, NORAD Cheyenne Mountain Complex Expansion Program. Mr Rochelle was honored for his outstanding performance in the accomplishment of all assigned tasks and for his continuous and technical abilities in the area of civil and sanitary engineering.

General Peters accepted the Best Author Award from George D. Hardy, Board Chairman, Air Force Association. The award, presented annually by the Aerospace Education Foundation of the Air Force Association, cited General Peters for his article "Application of Technology," which appeared in the August 1971 issue of the **Air Force Civil Engineer** journal.

Sergeant Joiner was presented his award by General Reilly. He was honored for his exceptional knowledge of heating systems operation and his professional insight into the requirement for and impact of the esprit de corps of the military and civilian maintenance personnel under his supervision.

Mr Lynam also received his award from General Reilly. He was cited for maintaining superior performance as foreman of the McGuire AFB Civil Engineering Maintenance Shop.

General Reilly presents Meritorious Award to 1st Lt J. M. Owendoff.

MSgt Abe Joiner receives NCO of the Year Award from General Reilly.

Neil Rochelle accepts Meritorious Award (civilian) from General Reilly.

George D. Hardy of AFA presents Best Author Award to General Peters.

Joseph Lynam accepts Foreman of the Year Award from General Reilly.

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